SELECTED WATER RESOURCES ABSTRACTS

VOLUME 3, NUMBER 12
JUNE 15, 1970

W70-04544 -- W70-05043

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SELECTED
WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center,
Office of Water Resources Research, U.S. Department of the Interior

VOLUME 3, NUMBER 12
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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, September 4, 1968.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.

- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin, jointly sponsored by the FWPCA, Soap and Detergent Association, and the Agricultural Research Service.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

In cooperation with the Federal Water Pollution Control Administration, the following "centers of competence" have been established:

- Thermal pollution at the Department of Sanitary and Water Resources Engineering of Vanderbilt University.
- Textile wastes pollution at the School of Textiles of North Carolina State University.
- Water quality requirements for freshwater and marine organisms at the College of Fisheries of the University of Washington.
- Wastewater treatment and management at the Center for Research in Water Resources of the University of Texas.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

CONTENTS

FOREWORD_____iii

SUBJECT FIELDS AND GROUPS

(Use Edge Index on back cover to Locate Subject Fields and Indexes in the journal.)

01 NATURE OF WATER
Includes the following Groups: Properties; Aqueous Solutions and Suspensions

02 WATER CYCLE
Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION
Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL
Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Non-Water Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION
Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING
Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA
Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS
Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

09 MANPOWER, GRANTS, AND FACILITIES
Includes the following Groups: Education—Extramural; Education—In-House; Research Facilities; Grants, Contracts, and Research Act Allotments.

10 SCIENTIFIC AND TECHNICAL INFORMATION
Includes the following Groups: Acquisition and Processing; Reference and Retrieval; Secondary Publication and Distribution; Specialized Information Center Services; Translations; Preparation of Reviews.

SUBJECT INDEX

AUTHOR INDEX

ORGANIZATIONAL INDEX

ACCESSION NUMBER INDEX

ABSTRACT SOURCES

SELECTED WATER RESOURCES ABSTRACTS

01. NATURE OF WATER

1A. Properties

ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
Geological Survey, Menlo Park, Calif.
K. L. R. Olevson.
Available for sale from Superintendent of Documents, US Government Printing Office, Washington, DC 20402-Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D189-D194, 1969. 6 p, 4 fig, 2 tab, 11 ref.

Descriptors: *Water properties, *Waves (Water), *Drops (Fluids), *Impact (Rainfall), Energy, Kinetics, Energy dissipation, Energy transfer.
Identifiers: *Raindrop craters (Water), Water craters (Impact), Liquid-liquid impacts.

Studies of transient craters in water, produced by falling water drops, show that significant amounts of energy are present as kinetic energy in a cylindrical wave which surrounds the crater when the crater has reached its maximum size. At maximum size, about 80 to 90% of the initial drop kinetic energy can be accounted for as potential energy, surface energy, and kinetic energy of the outwardly expanding cylindrical wave. The energy partitioning changes with velocity and crater size. For 14-milligram drops with velocities near 155 centimeters per second, surface energy is the most important energy sink, whereas potential energy is the most important energy sink at velocities near 566 cm per second. The percentage of kinetic energy in the cylindrical wave increases with increasing drop velocity and may exceed the percentage of surface energy for the highest velocities. (Knapp-USGS)
W70-04562

02. WATER CYCLE

2A. General

A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Civil Engineering.
George Bugliarello, and Eugene D. Jackson, III.
Text also printed in French. Journal of Hydraulic Research, Vol 7, No 2, p 177-204, 1969. 28 p, 12 fig, 1 tab, 9 ref.

Descriptors: *Diffusion, *Convection, *Mathematical models, Stochastic processes, Dispersion, Flow, Closed conduit flow, Steady flow, Statistical models, Tracers, Turbulent flow, Laminar flow.
Identifiers: Convective diffusion.

Stochastic methods can provide an alternative to conventional numerical techniques in the solution of the convective diffusion equation. A discrete model, consisting of a large number of particles, each executing in a discrete time interval a convective step and a random diffusive one, was used to simulate the diffusion pattern from continuous point sources in a laminar field. The treatment emphasizes methodological aspects and the type of information on the diffusion process that the simulation approach can most effectively provide. (Knapp-USGS)
W70-04563

URBAN EFFECTS ON WATER YIELD,
Geological Survey, Menlo Park, Calif.
For primary bibliographic entry see Field 04C.
W70-04574

EFFECTS OF URBANIZATION ON PEAK FLOWS,
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 04C.
W70-04576

URBAN EFFECTS ON THE UNIT HYDROGRAPH,
Tracor, Inc., Austin, Tex.; and Texas Univ., Coll. of Engineering.
For primary bibliographic entry see Field 04C.
W70-04577

PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
Geological Survey, Washington, D.C.
Frank W. Trainer.
Available for sale from Superintendent of Documents U S Government Printing Office, Washington, D C 20402-Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D222-D227, 1969. 6 p, 3 fig, 18 ref.

Descriptors: *Surface-groundwater relationships, *Rainfall-runoff relationships, *Base flow, Hydrograph analysis, Model studies, Maryland, Groundwater movement, Recession curves, Evaporation, Hydrologic budget, Hydrogeology, Streamflow.
Identifiers: Base runoff.

Base runoff from a small river basin in the Piedmont province in Maryland was studied through hydrograph separation during design of a study model depicting groundwater and base runoff in part of the Potomac River basin. Subsequent base runoff derived from individual storms, believed to be approximately equal to groundwater recharge resulting from these storms, ranges from 25 to 31% of the precipitation in February-April to 7 to 9% in July-September. On the average, a given quantity of precipitation results in three to four times as much base runoff during winter and spring as during summer and autumn. (Knapp-USGS)
W70-04581

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 04C.
W70-04723

LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
Agricultural Research Service, Beltsville, Md. Soil and Water Conservation Research Div.
For primary bibliographic entry see Field 04D.
W70-04725

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
Texas Univ., Austin, and Texas Tech Univ., Lubbock.
For primary bibliographic entry see Field 04C.
W70-04726

ANALYSIS OF WATERSHED CHANGES,
Hydrocomp International, Palo Alto, Calif.
For primary bibliographic entry see Field 07C.
W70-04728

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
Massachusetts Inst. of Tech., Cambridge.
Peter S. Eagleson.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 12-25, University of Texas Press, Austin and London, 1969. 14 p, 5 fig, 22 ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, *Hydraulic models, *Mathematical models, Statistical models, Hydraulic similitude, Simulation analysis, Routing, Runoff, Streamflow forecasting, Probability, Urbanization.
Identifiers: Watershed models, Watershed changes.

The construction, operation, and interpretation of hydraulic models and mathematical models of the rainfall-runoff relationships of watersheds are discussed. Emphasis is given to the effects of man made changes in watershed properties on their hydrologic performance. It is concluded that while there appears to be a class of watershed problems for which scale modeling may be a legitimate method study, the class is small and is included in that larger class for which digital computer solution of the equations of motion shows at least equal promise. The errors inherent in each approach have yet to be defined, but the digital computer should ultimately have a clear economic advantage. (See W70-04723). (Knapp-USGS)
W70-04729

THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
California Univ., Los Angeles. Dept. of Geography.
For primary bibliographic entry see Field 02B.
W70-04734

EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
Washington Univ., Seattle. Coll. of Forest Resources.
For primary bibliographic entry see Field 03B.
W70-04854

EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
Arizona Water Resources Research Center, Tucson.
Martin M. Fogel.
American Society of Agricultural Engineers, Transactions, Vol 12, No 6, p 808-812, November-December, 1969. 3 fig, 4 tab, 8 ref.

Descriptors: *Rainfall-runoff relationships, *Storm runoff, *Small watersheds, *Semiarid climates, *Regression analysis, Arizona, Seasonal, Summer, Precipitation (Atmospheric), Rainfall, Surface runoff, Duration, Spatial distribution, Variability, Convection, Depth-Area-Duration analysis, Equations, Storms, Estimating, Frequency analysis.
Identifiers: *Atterbury experimental watershed.

In the small semiarid watershed under study convective summer storms produce the heaviest runoff. The intensity, duration, frequency, and areal extent of these storms differ markedly from other storm types. A linear multiple-regression model was used in an attempt to discover the relative effects of depth of rainfall, its time distribution, and position of the storm over the watershed. Location of the storm had little or no effect on runoff if mean areal rainfall was used to characterize storm magnitude. The major influence in predicting runoff was mean rainfall, but time distribution of the storm did have a significant effect. In a comparison, the generally used U.S. Soil Conservation Service method was found to underestimate runoff for most storm rainfall depths and overestimate volume for extreme events. (Carr-Arizona)
W70-04910

2B. Precipitation

A GENERALIZED PROBABILITY MODEL FOR SEQUENCES OF WET AND DRY DAYS,
Liverpool Univ. (England).
J. R. Green.
Monthly Weather Review, Vol 98, No 3, p 238-241, March 1970. 4 p, 2 fig, 2 tab, 15 ref.

Descriptors: *Mathematical models, *Weather forecasting, Meteorology, Stochastic processes, Markov processes, Statistical models, Weather patterns.
Identifiers: Dry-day forecasts, Wet-day forecasts.

A generalization of the two main probability models used to describe runs of wet days or of dry days is given. The new model depends on only two parameters and is shown to fit a large proportion of available sets of data. (Knapp-USGS)
W70-04695

REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
Environmental Science Services Administration, Boston, Mass.
R. E. Lautzenheiser, A. E. Rothovius, and J. R. Sims.
Monthly Weather Review, Vol 98, No 2, p 164-168, February 1970. 5 p, 5 fig, 8 ref.

Descriptors: *Rainfall, *Rainfall intensity, *Distribution patterns, *New Hampshire, Rainfall disposition, Meteorology.
Identifiers: Small rain storms.

An excessive rain of very small areal extent fell late on Aug. 2, 1966, at Greenfield, N.H. The storm is described, related storm statistics are presented, the synoptic situation is reviewed, and the danger of interpreting point rainfall data as being representative of an area is shown. (Knapp-USGS)
W70-04698

A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
Rutgers - The State Univ., New Brunswick, N.J. Dept. of Meteorology.
Peter P. Zwack, Mark D. Shulman, and John W. Philpot.
Water Resources Bulletin, Vol 5, No 4, p 9-15, December 1969. 7 p, 1 fig, 4 tab, 14 ref.

Descriptors: *Precipitation (Atmospheric), *New Jersey, *Simulated rainfall, *Statistical models, *Synthetic hydrology, Simulation analysis, Rainfall disposition, Statistics, Model studies, Mathematical models, Computers, Time series analysis.
Identifiers: Precipitation simulation.

A 30-year record of monthly precipitation for Northern New Jersey was analyzed for its statistical components. With a weak annual periodicity eliminated, the series was found to be random. The data for each month were fit with a gamma distribution using Thom's suggested best estimates of the distribution parameters. A 1,000-year simulated monthly precipitation series was generated using random values from the 12 gamma distributions. The statistical properties of the simulated and sample time series agreed well. Numerous anomalous precipitation regimes were observed in the simulated data. (Knapp-USGS)
W70-04718

A NOTE ON AREAL RAINFALL DEFINITION,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
David M. Hershfield.
Water Resources Bulletin, Vol 5, No 4, p 49-55, December 1969. 7 p, 4 fig, 1 tab, 2 ref.

Descriptors: *Rainfall, *Distribution patterns, Statistical methods, Sampling, Mathematical studies, Probability, Instrumentation, Networks, Data collections, Rainfall disposition, Hydrology, Correlation analysis, Rain gages.
Identifiers: Rain gage networks.

Sources of error in defining areal rainfall on a storm basis include the instrumental error, sampling fluctuations over the area, and network density. Analysis of dense rain gage data show the magnitude of the errors resulting from the natural variability of rainfall. Except for one watershed in Arizona, the coefficient of variation, based on a sample of storm totals from the individual gages in various size areas, remains relatively constant with increasing area for a particular storm. The error due to rainfall variability over the area is probably the most important and must be considered in experiments which attempt to resolve small-area hydrologic problems. (Knapp-USGS)
W70-04719

FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
Rutgers - The State Univ., New Brunswick, N.J. Dept. of Meteorology.
A. Roger Greenway, and Mark D. Shulman.
Water Resources Bulletin, Vol 5, No 4, p 56-62, December 1969. 7 p, 1 tab, 6 ref.

Descriptors: *Weather forecasting, *Snow, *New York, Meteorology, Weather patterns, Precipitation (Atmospheric).
Identifiers: Snow forecasting.

The occurrence of rain and snow for New York City is examined in relation to atmospheric parameters at three levels for four first order weather bureau stations. An objective forecasting guide is developed using order statistic properties. Incorporating surface and upper level data, the guide is a highly accurate forecast tool. (Knapp-USGS)
W70-04720

THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
California Univ., Los Angeles. Dept. of Geography.
Werner H. Terjung, Ronald N. Kickert, Ronald J. Kochevar, Jack P. Mrowka, and Simon O. Ojo.
Archiv Meteorologie, Geophysik, und Bioklimatologie, Series B, Vol 13, p 21-50, 1969. 30 p, 16 fig, 3 tab, 50 ref.

Descriptors: *Solar radiation, *Mathematical models, *Synoptic analysis, *California, *Climatology, Albedo, Smog, Clouds, Topography, Slopes, Altitude, Urbanization, Meteorology, Heat balance.
Identifiers: Southern California.

A model based on theoretical knowledge of the physical modifications of solar energy by the atmosphere and its transformation at the surface, has been used to determine the monthly distribution of net radiation in southern California at a topoclimatic scale. Parameters utilized in the equations were cloud cover, cloud type, surface albedo, precipitable water vapor, surface temperature, slope angle, slope orientation, elevation, and urban smog. A remarkable contrast was found between relatively high net radiation values for the littoral and coastal mountains and those of the lower values of the arid eastern parts of southern California. (Knapp-USGS)
W70-04734

RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
Army Terrestrial Sciences Center, Hanover, N.H.
For primary bibliographic entry see Field 02C.
W70-04742

ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
National Center for Atmospheric Research, Boulder, Colo.

In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 865-880, 1966. 16 p, 1 fig, 3 append.

Descriptors: *Lakes, *Climatology, *Arid lands, *Reservoirs, Microclimatology, Meteorology, Precipitation (Atmospheric), Synoptic analysis.
Identifiers: *Egypt, *Lake Nasser, *Nile River.

The possible meteorological effects of the filling of Lake Nasser, Egypt are discussed, considering information on final size of the lake. During the months of June, July and August, the Nile is in flood; the water flow is highest and the water temperatures lowest of the year. At this time, the basic circulation of the lower atmosphere in the region to be occupied by Lake Nasser is the most stable of the year; it is essentially from the north around the extended monsoon low over northwest India. Mean maximum daily temperatures at Aswan are approximately 42 deg C. Winds are calm to light in the early morning hours but by mid-morning pick up to about 10-15 meters per second, blowing generally as north-east trades, very nearly parallel to the main axis of the water body of Lake Nasser. There are no clouds, dew points range to - 4 deg C, and there are no intrusions of other air masses. It is the consensus of scientists queried that the influence, if any, will be on the micro-to-meso scale. There seems to be little reason to expect that the moisture entering the atmosphere from the lake will, in the absence of any possibility of uplift to adequately low temperatures, result in clouds, much less precipitation. While thunderstorms do occur in the region at certain times of the year, with concomitant winds at low levels strong enough to blow sand, there appears to be little expectation that the presence of the lake will have any significant influence on the frequency of occurrence or intensity of such thunderstorms. (Knapp-USGS)
W70-04756

AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
Environmental Technical Applications Center (Air Force), Washington, D.C.
Dennis L. Boyer, and Alvin L. Smith, Jr.
Technical Note 69-6, August, 1969. 55 p, 141 ref.

Descriptors: Climatology, *Bibliographies, *Climatic data, *Precipitation (Atmospheric), Air temperature, Thunderstorms.
Identifiers: *India.

This bibliography contains 141 climatological references, with annotations, for India. Items are indexed by author (alphabetically) and by subject matter. All items listed were published subsequent to 1959.
W70-04981

2C. Snow, Ice, and Frost

EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
Catholic Univ. of America, Washington, D.C.
For primary bibliographic entry see Field 03A.
W70-04649

SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 08A.
W70-04694

SALT REJECTION BY SEA ICE DURING GROWTH,
Department of Energy, Mines and Resources, Dartmouth (Nova Scotia).
R. A. Lake, and E. L. Lewis.
Journal of Geophysical Research, Vol 75, No 3, p 583-597, January 20, 1970. 15 p, 10 fig, 1 tab, 18 ref.

Descriptors: *Sea ice, *Freezing, *Water chemistry, Sea water, Salts, Drainage, Structure, Physical properties, Crystal growth, Crystallization.
Identifiers: Salt rejection (Freezing).

Rejection of salt at a freezing ice-water interface takes place at least in part by cyclic convective processes occurring within the small interstitial spaces in the first few centimeters of ice above the interface. This invalidates the assumption of the

diffusive boundary layer and shows that near-interface temperatures are subject to cyclic variations. This result should be generally true for phase changes in aqueous solutions with floating ice, and it must be considered as a modification to current theories of solidification. Large vertical tubular structures with smaller tributary tubes exist in the growing sea ice sheet; this arrangement indicates horizontal migration of brine toward preferred drainage areas in a manner analogous to the catchment area of a river and its tributaries. (Knapp-USGS)
W70-04703

RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
Forest Service (USDA), Cadillac, Mich. North Central Forest Experiment Station.
Edward A. Hansen.
Forest Service Research Note NC-85, 1969. 4 p, 4 fig, 10 ref.

Descriptors: *Snowpacks, *Vegetation effects, *Forest management, Planting management, Snow management, Watershed management, Red pine trees, Pine trees, Water yield.
Identifiers: Vegetation-snow cover relations.

A snow accumulation study was conducted in a 33-year-old red pine plantation thinned to different stocking levels. Snowpack water content increased an average of 2% for each 10 square feet of basal area reduction, within the range of 60 to 180 square feet of basal area. Reducing plantation stocking from 180 to 60 square feet of basal area per acre would result in 1.4 to 1.9 inches of additional water in a winter when 6 to 8 inches of precipitation were received. (Knapp-USGS)
W70-04717

IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
Army Terrestrial Sciences Center, Hanover, N.H.
For primary bibliographic entry see Field 02K.
W70-04736

SOME PHYSICAL PROPERTIES OF ALPINE SNOW,
Army Terrestrial Sciences Center, Hanover, N.H.
Charles M. Keeler.
Cold Regions Research and Engineering Laboratory Research Report 271, December 1969. 70 p, 50 fig, 19 tab, 116 ref. DA Proj 1T061101A91A.

Descriptors: *Snow, *Physical properties, Adhesion, Bulk density, Electrical properties, Porosity, Thermal properties, Temperature, Bearing strength, Shear strength, Cryology, Rheology, Density, Avalanches.
Identifiers: Snow physical properties.

The fundamental properties of snow grain size, shape, and fabric (relationship between grains) were measured, and these were related to the index or derived properties of bulk density, shear and tensile strength, permeability for air, and the dielectric static permittivity and loss tangent. It was possible to show that: (1) snow strength is a function of bond area; and (2) the rate of densification of low density snow can be explained in part by high stress concentrations (on the order of 100 million dynes/sq cm) at intergranular contacts and by such factors as riming on crystals. The effect of the environmental factors of time, temperature, and gravitational stress is difficult to study in situ because they are not independent variables. However, it appears that their study is simplified when the fundamental properties of snow are correlated with index properties. (Knapp-USGS)
W70-04739

CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
Army Terrestrial Sciences Center, Hanover, N.H.
Herbert T. Ueda, and Donald E. Garfield.
Cold Regions Research and Engineering Laboratory Technical Report 231, December 1969. 19 p, 14 fig, 8 ref. DA Proj No 1T061101A91A.

Descriptors: *Ice, *Glaciers, *Antarctic, *Core drilling, Drilling, Rotary drilling, Drilling equipment, Sampling, Drill holes, Exploration, Subsurface investigations, Surveys, Drilling fluids, Heat flow.
Identifiers: Antarctic ice sheet, Ice coring.

The Antarctic ice sheet was penetrated by core drilling at Byrd Station during the 1967-68 austral summer. The drill was a cable-suspended electromechanical rotary type 87 ft long, weighing 2650 lb. Other equipment included 12,000 ft of armored electrical cable and a 70-ft-high aluminum tower. During 1966-67 the equipment was installed and a depth of 745 ft was drilled. Drilling resumed in November 1967 and the hole was completed in January 1968. Cores 10 to 20 ft long averaging 4 1/4 in. diam were recovered over 99% of the depth. The penetration rate averaged 70 ft/day. The drilling rate varied from 1.4 to 7.8 in./min at a power input of 7.5 to 9 kw. Drill cuttings were dissolved in an aqueous ethylene glycol solution circulated at the bottom of the hole and returned to the surface in the drill bailer on each coring run. Liquid water, indicative of pressure melting at the bottom of the ice sheet, was encountered at 7101 ft. Attempts to recover a core of sub-ice material were not successful. The hole began deviating from the vertical at 750-ft depth and, despite corrective measures, was inclined 15 deg at the bottom. Ice temperatures increased steadily from a minimum of -28.8 deg C at 2400 ft to -13.0 deg C at 5942 ft, where temperature measurement ceased. The heat flow for this location is estimated to be 1.8 microcal/sq cm/sec. (Knapp-USGS)
W70-04741

RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
Army Terrestrial Sciences Center, Hanover, N.H.
Michael A. Bilello.
Cold Regions Research and Engineering Laboratory Research Report 267, December 1969. 21 p, 6 fig, 3 tab, 26 ref, 1 append. DA Task 1T061102B52A02.

Descriptors: *Snow cover, *Climatology, *Density, Winds, Snow surveys, Temperature, Water yield, Snowfall.
Identifiers: *Snow density.

Analysis of snow-cover observations made during November to March at 27 stations in Alaska, Canada and the northern United States for a 2- to 11-year period showed that the average snow density can be classified in 4 general categories: Category 1 (density 0.20 to 0.23 g/cc), inland stations reporting light winds; Category 2 (0.24 to 0.27 g/cc), stations reporting moderate winds; Category 3 (0.28 to 0.30 g/cc), inland and coastal locations with stronger winds; Category 4 (0.32 to 0.36 g/cc), cold and windy stations of the Arctic. Skewness coefficients computed for each station showed bias toward lower densities for categories 1 and 2, and bias toward higher densities for categories 3 and 4. A nomograph in which the average winter air temperature and wind speed are the independent variables makes it possible to estimate the average snow-cover density for any location in the Arctic, subarctic and North Temperate Zones. A comparison between observed and estimated densities for 10 other test stations yielded a correlation coefficient of 0.91 with a standard error of estimate of 0.016 g/cc. An average snow density map of North America was drawn and the continent was divided into areas based on the 4 categories. (Knapp-USGS)
W70-04742

2D. Evaporation and Transpiration

THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
Cornell Univ., Ithaca; New York State Coll. of Agriculture, Ithaca. Dept. of Agronomy.
Ido Seginer.
Agricultural Meteorology, Vol 6, No 1, p 5-31, January 1969. 12 fig, 3 tab, 20 ref.

Descriptors: *Model studies, *Albedo, *Irrigation effects, *Evapotranspiration control, *Soil surfaces, Solar radiation, Arid lands, Radiation, Equations, Energy budget, Air temperature, Absorption, Canopy, Irrigated land, Photosynthesis, Time, Wetting, Wind velocity.
Identifiers: *Net radiation, *Reflectivity.

A model was used to evaluate the possibility of increasing the albedo of irrigated fields in order to reduce evapotranspiration. The results indicate that for infinite homogeneous fields the major factors determining the evaporation rate were albedo and wetness of surface. Following treatment savings in water were calculated to be 30% for all wetness conditions, with a 30% relative reduction in net radiation and a 20% reduction in solar radiation absorbed at the surface. Field experiments will be necessary to test these predictions. (Carr-Arizona)
W70-04919

A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
E. A. Fitzpatrick, and H. A. Nix.
Agricultural Meteorology, Vol 6, No 5, p 303-319, September 1969. 8 fig, 1 tab, 36 ref.

Descriptors: *Model studies, *Evaporation, *Evapotranspiration, *Soil water, *Fallowing, Crop production, Semiarid climates, Cotton, Sorghum, Wheat, Water loss, Water balance, Meteorological data, Climatology, Soil-water-plant relationships.
Identifiers: *Soil water reserves, Agronomic practices, Queensland, Australia.

A set of simple working functions depicting evaporative loss from an alternating fallow-crop system was used in a model for simulating soil water regime in sub-humid to semi-arid central Queensland. Despite inadequacies in the data, the model closely simulated changes over time in the soil water regime. This was achieved by using distinctive functions for fallowed and cropped intervals and by making evapotranspiration rates dependent upon status of available soil water and stage of crop development. Data were sufficient to allow formulation of functions for cotton, sorghum, and wheat. The model makes provision for future refinements in data and appears promising as a basis for assessing effects of varied agronomic practices on available soil water reserves. (Carr-Arizona)
W70-04920

CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.; and Army Electronics Command, Fort Huachuca, Ariz. Atmospheric Sciences Lab.
C. H. M. Van Bavel.
Agricultural Meteorology, Vol 4, No 3, p 165-176, May 1967. 10 fig, 1 tab, 1 append, 19 ref.

Descriptors: *Evaporation, *Soil-water-plant relationships, *Moisture stress, *Canopy, *Irrigation effects, Plant physiology, Irrigation, Alfalfa, Arizona, Arid lands, Diurnal, Stomata, Water loss, Resistance, Equations, Meteorological data, Energy budget.

Identifiers: *Canopy resistance.

An Arizona alfalfa field was irrigated and then allowed to deplete its soil water reserves down to -15 bars. The ratio between actual and potential evaporation was followed hourly, and when it dropped significantly below unity was interpreted as canopy resistance to evaporation. This resistance followed a diurnal pattern, with low values in the early morning, a rapid increase in early afternoon, and a decrease toward evening. It was not until 20 days after irrigation that resistance became noticeable during the day. However, from that time until the end of the experiment resistance rose rapidly and on the last day of measurement showed a value of 15 sec/cm. It would appear from the data that alfalfa stomata hold evaporation to a daily maximum value which declines as soil water is depleted. (Carr- Arizona)
W70-04921

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
Leo J. Fritschen.
Agricultural Meteorology, Vol 4, No 1, p 55-62. 1 tab, 12 ref. Jan 1967.

Descriptors: *Irrigation water, *Regression analysis, *Solar radiation, *Evapotranspiration, *Albedo, Irrigation design, Water conservation, Arid lands, Irrigation efficiency, Arizona, Radiation, Surfaces, On-site data collections, Meteorological data, Data collections, Analytical techniques, Crops.
Identifiers: *Net radiation, Linear regression.

In an attempt to determine the relation between solar radiation and net radiation, data were collected over field crops of alfalfa, barley, cotton, oats, sorghum, and wheat. Field data were analyzed by linear regression techniques and the standard error which resulted from the pooled data was 0.06 ly/min. If net radiation were estimated from solar radiation for a 12-hour day with 649 ly incoming radiation, a standard error of approximately 10% would result. This pooled regression would be sufficiently accurate to estimate evapotranspiration in the design of irrigation projects, but the error would be too large in cases needing daily evapotranspiration results. In studying the reflectivity of crop surfaces, it appears that water may be conserved by increasing the surface albedo of crops and of wet bare soil. (Carr-Arizona)
W70-04922

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
California Univ., Riverside; and Arizona Agricultural Experiment Station, Tucson.
C. H. M. Van Bavel, J. E. Newman, and R. H. Hilgeman.
Agricultural Meteorology, Vol 4, No 1, p 27-37, January 1967. 4 tab, 10 ref.

Descriptors: *Evapotranspiration, *Climates, *Arid climates, *Orchards, *Water utilization, Oranges, Stomata, Canopy, Wind velocity, Arizona, Equations, Meteorological data, Leaves, Evaporation, Evaporation pans, Data collections, Air temperature, Analytical techniques, Resistance, Water vapor.
Identifiers: *Canopy resistance, Penman equation.

A modified Penman equation applied to commonly logged climatic data was used to estimate potential evapotranspiration from orange trees under arid conditions in Arizona. Due to canopy resistance to evaporation, actual water use was much lower than the potential rate. There were further indications that in an arid environment evaporation from citrus groves is inversely related to wind speed and that aging leaves show increased values of canopy resistance. These results demonstrate the potential value of a physical approach to the prediction of crop water use. (Carr-Arizona)
W70-04923

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
H. A. Nix, and E. A. Fitzpatrick.
Agricultural Meteorology, Vol 6, No 5, p 321-337, September 1969. 4 fig, 4 tab, 3 append, 21 ref.

Descriptors: *Moisture stress, *Crop production, *Evapotranspiration, *Soil-water-plant relationships, *Soil water, Moisture deficit, Climatic data, Rainfall, Plant physiology, Wheat, Sorghum, Environmental effects, Data collections, Regression analysis, Phenology.
Identifiers: *Stress index, *Queensland, Australia.

Soil-water regimes for wheat and grain sorghum were studied in experiments in central Queensland. Analysis of the ratio of estimated actual to potential evapotranspiration at defined intervals of growth for both crops revealed a critical growth period from ear emergence to early grain development. Ratios calculated for this 'critical' period correlated more closely with yield than other indices used to characterize crop water environment. A simple index incorporating available soil water supply and potential evaporative demand gave highly significant correlations with yields. This index accounted for 60-83% of the yield variation within the different varieties under study. After checking these findings against wheat yield data in Queensland for the 1952-1965 period, it would appear that intra-seasonal and year-to-year variation in yield is largely a function of anthesis date in relation to the then prevailing environmental moisture stress. (Carr-Arizona)
W70-04924

2E. Streamflow and Runoff

HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
Soil Conservation Service, Iowa City, Iowa; and Iowa State Water Resources Research Inst., Ames.
R. V. Ruhe, and W. J. Vreeken.
Available from the Clearinghouse as PB-190 166, $3.00 in paper copy, $0.65 in microfiche. Iowa State University Water Resources Research Institute Project Completion Report, December 31, 1969. 44 p, 37 fig, 5 plate, 1 tab, 15 ref. OWRR Project No A-014-IA.

Descriptors: *Hydrogeology, *Rainfall-runoff relationships, *Iowa, *Loess, Glacial drift, Topography, Geology, Discharge (Water), Runoff, Water yield, Base flow, Erosion, Scour, Channel morphology, Hydrographs, Statistical methods.
Identifiers: Four Mile Creek (Iowa), Tama County (Iowa).

Topography in the Four Mile Creek area, Iowa consists of stepped levels that rise along interfluves from the main valley to divides. The drainage net is incised along tributary and side streams. Maximum relief in the area is 135 feet. Wisconsin loess covers 54% of the area and buries paleosols and glacial till. The loess varies in thickness from 4 to 35 feet. Alluvium is confined to the main, tributary, and side valleys. The main valley alluvium occupies 22% of the area. In relatively drier years, runoff is only 4 to 6% of rainfall, and in wetter years, runoff may be 11 to 17% of rainfall. The hydrologic regimen within small first-order watersheds in loess is related to stratigraphic zoning in the loess reservoir and to topography inherited from paleogeomorphic surfaces. These surfaces have associated clayey paleosols that are more impermeable than the loess. Parts of the buried surfaces are cut in till, also more impermeable than the loess. Subsurface water transmits downward and laterally through the permeable loess reservoir above the buried surfaces to alluvium along the first-order drainage. The subsurface water subsequently flows to alluvium of higher order valleys in the drainage net and ultimately to the main alluvial body along Four Mile Creek. (Knapp-USGS)
W70-04545

VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
Imperial Coll. of Science and Techology, London (England).
J. R. D. Francis, and A. F. Asfari.
Nature, Vol 225, No 5234, p 725-728, February 1970. 4 p, 8 fig, 3 ref.

Descriptors: *Open channel flow, *Meanders, *Vortices, *Hydraulic models, *Photography, Instrumentation, Flumes, Lighting, Cameras, Model studies, Turbulent flow, Streamflow, Tracers, Tracking techniques.
Identifiers: Spiral flow.

A method is described for observing motions in two laboratory open channels of 180 deg bends of different curvature and width. The secondary currents responsible for forming the spiral motion were made visible and recorded by a photographic technique. Photographs of the secondary currents were taken using exposures at two cross-sections, and at two depths of flow (h=7.6 cm and 3.75 cm). The patterns of secondary flow at these cross-sections were recorded by photographing, in a direction perpendicular to the cross-section concerned, illuminated tracer particles. Two tracer agents were used: in laminar flow, a plastic powder, specific gravity, 0.96; particle size range, 0.1-0.2 mm; in turbulent flow, droplets of a mixture of nitrobenzene, olive oil and water. The study concludes that when the aspect ratio of the flow (b/h) increases, the strength of secondary currents, as represented by the flow deviation from the circumferential direction, decreases. (Knapp-USGS)
W70-04553

TRANSFERRING STREAMFLOW CHARACTERISTICS,
Geological Survey, Washington, D.C.
H. C. Riggs.
ASCE Meeting Preprint 1093, American Society Civil Engineers Meeting, Jan 26-30, 1970, Memphis, Tennessee. 18 p, 5 fig, 1 tab, 7 ref.

Descriptors: *Streamflow forecasting, *Statistical methods, Regression analysis, Rainfall-runoff relationships, Hydrologic data, Data processing, Hydrographs, Water measurement, Forecasting, Estimating, Sampling.
Identifiers: Streamflow characteristics transfer.

The design of water-resource developments and protection works requires estimates of the statistical characteristics of streamflows such as flood peaks and annual minimum flows of selected recurrence intervals, and annual and seasonal means and their variabilities. At gaged sites, these characteristics may be obtained directly from the streamflow records. At ungaged sites, to transfer natural-flow data, a general procedure called regionalization uses data from many gaged sites in a region to produce a relation applicable to any ungaged site in that region. Other methods transfer information from one gaged site to a specific ungaged site at which a small amount of information has been collected. Four general procedures for transferring flow characteristics are described. (Knapp-USGS)
W70-04554

ACCURACY OF STREAMFLOW CHARACTERISTICS,
Geological Survey, Washington, D.C.
Clayton H. Hardison.
Available for sale from Superintendent of Documents U S Government Printing Office, Washington, D C 20402-Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D210-D214, 1969. 5 p, 3 fig, 4 tab, 5 ref.

Descriptors: *Streamflow forecasting, *Analytical techniques, *Statistical methods, *Data processing, Correlation analysis, Regression analysis, Sampling, Data collections, Estimating.

Identifiers: Streamflow characteristics, Data accuracy, Error analysis.

Streamflow information, which is one of the end products of the Water Resources Division of the U. S. Geological Survey, may be obtained directly from a streamflow record or may be derived from base data by analytical methods. In either case, accuracy goals for the information obtained are needed to test the adequacy of the information and to design the data-collection system upon which the information is based. It is proposed that the accuracy goal for each streamflow characteristic be set equivalent to the accuracy with which that characteristic could be estimated from an observed record of some stipulated length. Curves and tables are presented in this paper to aid in setting such goals. (Knapp-USGS)
W70-04564

RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
Geological Survey, Menlo Park, Calif.
J. T. Limerinos.
Available for sale from Superintendent of Documents U S Government Printing Office, Washington, D C 20402 Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D215-D221, 1969. 7 p, 1 fig, 3 tab, 6 ref.

Descriptors: *Roughness (Hydraulic), *Mannings equation, Alluvial channels, Particle size, Particle shape, Statistical methods, Regression analysis, Roughness coefficient, Flow resistance.
Identifiers: Particle smoothness (Hydraulic).

An objective method of determining basic values of the Manning roughness coefficient was studied in channels with coarse bed material. Data were obtained from 50 current-meter measurements of discharge and appropriate field surveys at 11 sites on California streams. Characteristic bed-particle sizes, including the 16-, 50-, and 84-percentile sizes, for both minimum and intermediate axes were used to find the best relation between the roughness parameter and relative smoothness. The relations best fitting the field data were obtained when the characteristic particle size was either the 84-percentile d84 or a weighted composite size dw. Percentage differences for the 50 observed and computed values of n involving either d84 or dw had a standard deviation of about 19%. The form of the derived equations, using d84 or dw, was virtually identical with theoretical equations presented by Chow in 1959 and Vennard in 1961 and with an equation derived from field data by Leopold and Wolman in 1957. (Knapp-USGS)
W70-04565

EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
Soil Conservation Service, Fort Worth, Tex. Engineering and Watershed Planning Unit.
For primary bibliographic entry see Field 04A.
W70-04571

FIELD EXPERIMENT ON WASHITA RIVER,
Agricultural Research Service, Chickasha, Okla. Southern Plains Branch.
For primary bibliographic entry see Field 04D.
W70-04572

EFFECTS OF URBANIZATION ON PEAK FLOWS,
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 04C.
W70-04576

EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
Turner, Collie and Braden Co., Inc., Houston, Tex.
For primary bibliographic entry see Field 04C.
W70-04578

PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 02A.
W70-04581

ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
Societe Grenobloise d'Etude et d'Applications Hydrauliques (France).
J. A. Cunge.
Text also printed in French. Journal of Hydraulic Research, Vol 7, No 2, p 205-230, 1969. 26 p, 5 fig, 5 ref.

Descriptors: *Routing, *Mathematical studies, *Flood routing, *Stage-discharge relations, Computers, Mathematical models, Discharge (Water), Flood forecasting, Hydrology.
Identifiers: Muskingum method, Saint-Venant equations.

The Muskingum flood wave propagation computation method and variants of it are in current use. It is a convenient method as the computer calculations can be rapidly carried out even with a machine of limited capacity. The basic assumption for the method is that the stage/discharge relationship is one-to-one, and strictly applied, this assumption leads to a differential equation whose analytical solution does not allow for wave damping. The Muskingum method, however, gives the attenuation of a wave travelling along a stream. Analysis of the Muskingum formula shows it also to be a finite-difference approximation of another differential equation derived from the Saint-Venant equations by neglecting the inertia terms. There is a solution to this equation which allows for damping of the flood wave. By comparing this differential equation with the Muskingum formula the coefficients of the latter can be determined from the physical river characteristics, but the stage/discharge relationship can then no longer be assumed to remain one-to-one. (Knapp-USGS)
W70-04590

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
Geological Survey, Oklahoma City, Okla.
For primary bibliographic entry see Field 02F.
W70-04601

FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
Geological Survey, Washington, D.C.
E. M. Miller.
Geological Survey Hydrologic Investigations Atlas HA-409, 1 sheet, 1969. Text, 2 fig, 1 photo, 1 map, 1 tab.

Descriptors: *Floods, *Virginia, *Hurricanes, *Historic flood, Cloudbursts, Peak discharge, Rain, Rain water, River flow, Storm runoff, Stage-discharge relations.
Identifiers: James River (Va), Richmond (Va).

The approximate areas inundated in and near Richmond, Va., by the flood of August 22, 1969, on the James River are shown on a topographic map. The flood was caused by torrential rains brought by the remnants of Hurricane Camille. The flood of May 1771 is considered the greatest in the James River basin since the settlement of Jamestown in 1607. The August 1969 flood at the Virginia Division of Water Resources gaging station, 0.1 mile upstream from the Huguenot Memorial Bridge (river mile 111.7), reached a stage of 24.95 feet, gage datum, (discharge, 222,000 cfs) and was the highest for the period of record (1935-69). At the U. S. Weather Bureau gaging station at river mile 103.7, the flood reached a stage of 28.6 feet, msl, (29.9 ft at former site of U. S. Weather Bureau gaging station at river mile 104.6), and was the highest since the great flood of 1771. (Knapp-USGS)
W70-04602

BIG BLUE RIVER BASIN.
Nebraska Soil and Water Conservation Commission, Lincoln.

Nebraska State Water Plan Publication No 201, September 1968. 103 p, 21 fig, 22 tab, 13 ref.

Descriptors: *Water resources development, *Groundwater, *Surface waters, *Nebraska, Irrigation water, Recreation, Flood control, Erosion control, Reservoirs, Planning, Hydrogeology, Hydrology, Geology.
Identifiers: Big Blue River basin (Nebr).

The Big Blue River basin of Nebraska has large acreages of deep productive soils, highly variable but generally adequate rainfall, and somewhat erratic streamflow. The major industry in the basin is diversified agriculture and related agriculturally oriented enterprises. This area is predominantly agricultural in nature. Groundwater storage reservoirs are quite extensive in the upper and central parts of the basin. The groundwater table is currently declining in localized areas of high concentration of irrigation wells. The main source of irrigation water has been from groundwater but excessive rates of water level decline in some areas indicate that better water management is needed. The primary needs evidenced in the basin are: flood control in the lower reaches of the streams, stabilization of the groundwater table in the upper and central basin, erosion control throughout the basin, drainage of certain depressional areas in the upper and central basin, stabilization of the economy, and provision of more recreation opportunity, especially water-oriented recreation. (Knapp-USGS)
W70-04603

FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.
Corps of Engineers, Honolulu, Hawaii.
For primary bibliographic entry see Field 04A.
W70-04713

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 04C.
W70-04723

FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
Corps of Engineers, Savannah, Ga.
For primary bibliographic entry see Field 04A.
W70-04738

STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
For primary bibliographic entry see Field 04A.
W70-04744

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
For primary bibliographic entry see Field 04A.
W70-04745

THE OPERATION OF REGULATING RESERVOIRS,
Water Resource Board, Reading (England). Research Div.
For primary bibliographic entry see Field 04A.
W70-04746

FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
For primary bibliographic entry see Field 04A.
W70-04750

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 04C.
W70-04832

EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 02A.
W70-04910

EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
Iowa State Water Resources Research Inst., Ames.
For primary bibliographic entry see Field 04A.
W70-04984

METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
Hydrometeorological Centre, Moscow (USSR).
For primary bibliographic entry see Field 04A.
W70-05019

GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
Water Research Association, Medmenham (England).
For primary bibliographic entry see Field 04A.
W70-05020

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
Geological Survey, Tucson, Ariz.
Thomas Maddock, Jr.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 812-823, 1966. 12 p, 6 fig, 10 ref.

Descriptors: *Alluvial channels, *Reservoirs, *Sedimentation, Sediment transport, Deposition (Sediments), Aggradation, Sediment control, Vegetation effects, Reservoir silting, Channel morphology, Roughness (Hydraulic).
Identifiers: Upstream channels (Reservoirs).

Channel gradients above and below reservoirs, and even check dams have had little study. Recent statistical studies of gradients above check dams have been inconclusive. It is shown that the important factor yet unconsidered is the hydraulic relative roughness of the channel before and after the construction of the impeding structure. Since, for the same purely alluvial channel, roughness of an aggrading stream is less than that for a 'normal' stream, the gradients above dams are usually less than the natural gradient of a stream. Growth of vegetation introduces a complicating factor into the behavior of channels in alluvium. Sediment deposits behind dams are likely places for heavy vegetative growth. This may result in the deposit of unusual amounts of fine grained sediment and an increase in the stream gradient. Thus, the final gradient of a channel upstream from an obstruction may be largely dependent on the character of the vegetation growing on the newly laid deposits of sediment. (Knapp-USGS)
W70-05023

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07A.
W70-05026

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
Electricite de France, Chatou. Centre de Recherches et d'Essais.
For primary bibliographic entry see Field 04A.
W70-05028

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
Water Research Association, Medmenham (England).
For primary bibliographic entry see Field 04A.
W70-05029

DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
Electricite de France, Grenoble. General Technical Div.
For primary bibliographic entry see Field 04A.
W70-05030

PROBABILISTIC RESERVOIR DESIGN,
Lancaster Univ., Bailrigg (England). Dept. of Mathematics.
For primary bibliographic entry see Field 04A.
W70-05031

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
Ente Nazionale per l'Energia Elettrica, Venice (Italy).
For primary bibliographic entry see Field 04A.
W70-05032

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
Reditelstvi Vodnich Toku, Prague (Czechoslovakia).
For primary bibliographic entry see Field 04A.
W70-05033

USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).
Pierre Dubreuil.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 551-558, 1966. 8 p, 3 fig, 2 ref.

Descriptors: *Water storage, *Reservoirs, *Estimation, Maps, Channel morphology, Depth, Streamflow forecasting, Statistical methods.
Identifiers: *Brazil.

Water storage in tens of thousands of small reservoirs in the Brazilian north-eastern region is estimated using a sample of 200 reservoirs, all physical characteristics of which are known. It is possible to establish relations to eliminate the pool depth and thalweg form factors. Then the storage capacities can be calculated from the pool surface and drainage basin length, both measured on maps. On the total volume, the error is not expected to exceed 25%. (Knapp-USGS)
W70-05034

2F. Groundwater

HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
Soil Conservation Service, Iowa City, Iowa; and Iowa State Water Resources Research Inst., Ames.
For primary bibliographic entry see Field 02E.
W70-04545

ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
Geological Survey, Lincoln, Nebr. Water Resources Div.
H. M. Babcock, and C. F. Keech.
Geological Survey Open-file report, May 1969 (revised). 15 p, 2 fig, 1 plate, 3 tab.

Descriptors: *Groundwater movement, Underflow, *Wyoming, *Nebraska, Groundwater basins, Water resources development, Water yield, Discharge (Water).
Identifiers: Niobrara River basin (Wyo-Neb).

Underflow at the Wyoming-Nebraska State line was estimated by applying Darcy's law to measured permeabilities and water levels, and by water budget methods. The coefficient of transmissibility of the Arikaree Group along the Wyoming-Nebraska State line is estimated to be between 15,000 and 30,000 gpd per foot. The underflow is estimated to be between about 5,000,000 and 8,000,000 gpd. Of the factors used in determining the amount of underflow, the largest probable error lies in the determination of the coefficient of permeability. (Knapp-USGS)
W70-04593

SPRINGS IN THE OZARK REGION, NORTHEASTERN OKLAHOMA,
Geological Survey, Oklahoma City, Okla. Water Resources Div.
Roy H. Bingham.
Oklahoma Geology Notes, Vol 29, No 6, Oklahoma Geological Survey, p 135-145, December 1969. 11 p, 7 fig, 3 tab, 4 ref.

Descriptors: *Springs, *Oklahoma, Karst, Recharge, Discharge (Water), Water yield, Water quality, Hydrogeology, Hydrologic data, Runoff, Aquifers.
Identifiers: Ozark Region (Okla).

Springs are a large potential source of good quality water in northeastern Oklahoma. Discharge measurements during September and October 1968 show that 26 of the largest springs were flowing about 21 mgd, an amount sufficient to furnish domestic supplies to a population of about 200,000. Data on the springs were collected during a reconnaissance of the water resources in the Tulsa quadrangle. The existence and location of springs in this regions depend upon the position of the water table, the topography of the area, and the lithology and structure of the geologic formations. The only geologic features described are those that are necessary to provide an understanding of the physical framework through which groundwater moves. (Knapp-USGS)
W70-04594

VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
Kyoto Univ. (Japan). Disasters Prevention Research Inst.
Yoshiaki Fukuo.
Bulletin of the Disaster Prevention Research Institute, Vol 19, Part 1, Paper 150, p 1-13, August 1969. 13 p, 4 fig, 6 ref.

Descriptors: *Aquifers, *Groundwater movement, *Elastic deformation, *Elasticity (Mechanical), Rock properties, Aquicludes, Artesian wells, Water levels, Confined water.
Identifiers: Confined aquifers, Aquifer elasticity, Pore water.

A dynamic theory was derived for the deformation of a granular solid saturated with a liquid, assuming that the liquid filling up the pore space is a Newtonian viscous fluid and that the skeleton constituted by solid particles is a linear visco-elastic solid. The theory consists of the three fundamental equations, that is, the equations of motion of the liquid and the skeleton and the equation of continuity between the particles and the liquid. If the particle and liquid are taken to be incompressible

and the deformation of soil takes place on a quasi-static process, these equations are accepted as the theory of three-dimensional consolidation, including Terzaghi's well-known equation as a special case, and are also recognized as the basic equations of motion of confined groundwater in a visco-elastic aquifer. A theoretical example shows the rheological deformation of an infinite confined aquifer with uniform thickness caused by pumping water at a constant rate. (Knapp-USGS)
W70-04595

AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
Nebraska Univ., Lincoln. Conservation and Survey Div.
Frank A. Smith.
Nebraska University Conservation and Survey Division Report, April 1969. 10 p, 1 fig, 1 tab, append.

Descriptors: *Water resources, *Groundwater, *Irrigation water, *Nebraska, Alluvium, Hydrogeology, Water yield, Water levels, Water table, Transmissivity, Water wells, Aquifers.
Identifiers: Cheyenne County (Nebr).

Three different stratigraphic units are sources of water supplies in Cheyenne County, Nebraska. Most wells in valleys tap either alluvial deposits of Quaternary age or the underlying Brule Formation of Tertiary age; a few may tap the Ogallala Formation, also of Tertiary age but younger than the Brule. Most wells on the tablelands derive water from the Ogallala Formation alone. Generally, the alluvial deposits are mostly fine grained or thin and capable of yielding only small supplies to wells. Plans for development of irrigation supplies should take into consideration the fact that the groundwater resources will last only 30, 50, 100 years or more, depending on the intensity of the development. Well data, including drillers' logs, are tabulated. Maps, scaled about 2 miles per inch, show potential well yield, top of the Brule Formation, and the configuration and depth of the water table. (Knapp-USGS)
W70-04596

HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
Geological Survey, Denver, Colo.
E. H. Cordes.
Geological Survey Open-file Report, December 1969. 42 p, 12 fig, 8 ref.

Descriptors: *Hydrogeology, *Oil shale, *Colorado, *Nuclear explosions, Permeability, Transmissivity, Water pollution sources, On-site tests, Geologic investigations, Water wells, Hydrologic data, Aquifers.
Identifiers: Project bronco, Pumping tests, Aquifer testing.

On November 21, 1967, the U. S. Geological Survey completed the hydraulic testing and sampling of USBM-AEC Colorado Core Hole 3 in Rio Blanco County, Colorado. This hole was drilled to explore the site for Project Bronco, a Plowshare experiment to study the feasibility of in situ retorting of oil shale after breaking the rock with a nuclear explosion. The hydraulic tests indicate the existence of a highly permeable water-bearing zone in the upper and middle parts of the Parachute Creek Member of the Green River Formation. The zone yielded water in excess of 2,700 cubic meters per day. Natural groundwater circulation dissolved the salt deposits from a part of the oil shale, leaving a highly permeable zone. Underlying rocks are comparatively impermeable, and yielded less than 16 cubic meters per day of highly saline fluid. Potential flooding of a rubble chimney is an important consideration for project feasibility and safety. A first approximation of the magnitude of flooding was calculated from the test data. (Knapp-USGS)
W70-04598

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
Geological Survey, Oklahoma City, Okla.
Melvin V. Marcher.
Oklahoma Geological Survey Hydrologic Atlas 1, 1969. 4 sheets, text, 6 fig, 5 map, 3 tab, 30 ref.

Descriptors: *Water resources, *Groundwater, *Surface waters, *Oklahoma, Water supply, Water wells, Water yield, Aquifers, Geology, Water quality, Streamflow, Precipitation (Atmospheric).
Identifiers: Fort Smith (Okla).

The geology and water resources of the Fort Smith quadrangle, Oklahoma are shown by a 4-sheet hydrological atlas consisting of a geological map, a groundwater availability map, a groundwater quality map, a map showing distribution of precipitation, hydrographs, tabulated data, and descriptive text. In some parts of the Fort Smith quadrangle, wells readily yield several hundred gallons of water per minute suitable for most purposes, whereas in other parts, supplies of water sufficient for daily household use are difficult to obtain and much of this water is of poor quality. Differences in well yield and water quality are controlled mainly by the type of rock in which a well is completed. In general, alluvium is the most favorable type of rock for large well yields, followed by terrace deposits in local areas and then, in order of decreasing favorability, weathered chert, limestone, sandstone, and siltstone, with shale the least favorable. In addition to rock type, geologic structure also affects the occurrence of groundwater, particularly in the northeastern part of the area where springs and some of the wells of larger yield apparently obtain water from rocks broken by faulting. Minor streams in the area go dry or nearly dry almost every year. Alluvium yields groundwater of the best quality and shale to poorest, whereas other rock types yield water with a quality somewhere between. Groundwater that has been in contact with coal beds is usually highly mineralized and, in some places, unfit to drink. Coal mining and oil- and gas-field development may adversely affect the water quality locally. (Knapp-USGS)
W70-04601

BIG BLUE RIVER BASIN.
Nebraska Soil and Water Conservation Commission, Lincoln.
For primary bibliographic entry see Field 02E.
W70-04603

EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
Geological Survey, Miami, Fla. Water Resources Div.
F. A. Kohout, and Howard Klein.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 252-270, 1967. 19 p, 14 fig, 8 ref.

Descriptors: *Recharge, *Saline water intrusion, *Groundwater movement, *Aquifers, *Florida, Water quality, Water yield, Discharge (Water), Hydraulic gradient, Water storage, Permiability, Transmissivity, Infiltration.
Identifiers: Miami (Fla), Biscayne aquifer.

In the Biscayne aquifer of the Miami area, Florida, the salt front is dynamically stable at a position as much as 8 miles seaward of that computed according to the Ghyben-Herzberg principle. When the fresh-water head is low, sea water flows inland into the deep part of the aquifer, moves upward, and flows back to the sea through the upper part. The cycle limits the extent to which sea water invades the aquifer. During periods of heavy rainfall large quantities of fresh water are stored below sea level, while deep saline water is driven seaward under steep seaward hydraulic gradient. The effects of these heavy pulses of recharge are demonstrated by biweekly mappings of the isochlor pattern after a 13-inch rainfall. The flow diagrams show that forceful expulsion of salt water after heavy rains results in more efficient recharge than discharge because fresh water is injected into storage throughout the full aquifer thickness, whereas during the subsequent saline intrusion, fresh water is discharged through only about 1/3 of the aquifer thickness. (Knapp-USGS)
W70-04606

ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
For primary bibliographic entry see Field 04B.
W70-04608

A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
Oklahoma State Univ., Stillwater.
Richard N. DeVries.
Pap, 1969 Nat Water Well Exposition, Sept-Oct, 1969. 30 p, 3 fig, 15 tab, 6 ref, 4 append.

Descriptors: *Water wells, *Wells, *Mathematical models, Permeability, Operations, *Municipal water, Nebraska, Theis equation, *Model studies, Computer programming, Drawdown, Groundwater recharge, Groundwater flow, Storage coefficient, Pumping, Groundwater mining, *Aquifers.
Identifiers: *Hydrologic models, Groundwater depletion, Pumping tests, Groundwater hydrology, Platte River (Nebr).

Increased irrigation demands on water from the Platte River in central Nebraska are causing a depletion in the flow passing Lincoln's municipal well field at Ashland, Nebr. A study was made for the US Army Engineers, Omaha District, on the future harmful effects of the depletion. A mathematical model using the Theis nonequilibrium equation was formulated. Drawdown computations were performed using a computer. Recharging image wells represented the physical boundary of the aquifer. Drawdowns in selected wells were calculated using the method of superposition by including real wells and image wells. Values for permeability and the storage coefficient were computed from field pumping test data. Three model runs were made. The well field was operable at high rates for periods of greater than 30 days with recharge from the river. Previous studies indicated that the river was the source of most water produced from the wells. The well field can draw on the groundwater reservoir for much longer periods than had been assumed. (USBR)
W70-04619

GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
Kansas State Geological Survey, Lawrence.
William J. Seevers.
Kansas Geological Survey Bulletin 193, November 1969. 65 p, 9 fig, 1 plate, 4 tab, 66 ref.

Descriptors: *Water resources, *Groundwater, *Geology, *Kansas, Aquifers, Data collections, Hydrologic data, Hydrogeology, Water wells, Water yield, Water levels, Water quality.
Identifiers: Linn County (Kansas).

Linn County is located along the Kansas-Missouri boundary in east-central Kansas and is a nearly square area of about 605 square miles. Only very small quantities of groundwater are obtained from Pennsylvanian rocks in Linn County. Yields rarely exceed 1 gallon per minute and are normally barely sufficient for domestic purposes. Limestones are the most productive aquifers, and limestones of the lower part of the Kansas City Group are the best of the bedrock aquifers. Groundwater below a depth of about 100 feet in this area is normally too highly mineralized for use. Large quantities (30 to 100 gpm) of good quality water are obtained from properly constructed and developed wells in Il-

linoisan and Wisconsinan valley-fill deposits, mainly from thin gravel deposits near the base. (Knapp-USGS)
W70-04732

THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
Water Resources Board, Reading (England). Groundwater Div.
R. A. Downing, and B. P. J. Williams.
Water Resources Board Publication No 9, Reading, England, 1969. 160 p, 44 fig, 4 plate, 19 tab, 58 ref.

Descriptors: *Hydrogeology, *Aquifers, *Water supply, *Limestones, Hydrology, Transmissivity, Water resources development, Groundwater, Water wells, Artesian wells, Geology, Recharge, Artificial recharge.
Identifiers: Lincolnshire Limestone (England).

The Lincolnshire Limestone, forming part of the Jurassic Inferior Oolite Series of England, is a hard compact limestone incorporating oolitic and pisolitic limestones (which are commonly shelly), calcite mudstones, and locally developed sandy limestones. Both vertical and lateral variations in lithology are ubiquitous. The Limestone thins to the north and south of the Grantham area where the maximum thickness is about 130 ft (40 m). Groundwater flow is mainly through fissures. In South Lincolnshire the water in the Limestone is confined under pressure over a considerable area, and overflowing conditions exist in the low lying ground forming the Fens. High transmissibilities may be due to the solvent action of groundwater moving relatively freely through the aquifer during the Pleistocene period to discharge points in deep channels (now infilled with drift) centered on the Wash. Groundwater in the outcrop zone is of the calcium bicarbonate type, changing gradually to a sodium bicarbonate type and ultimately to a sodium chloride type in a downdip direction. The Limestone is developed extensively for water supply in South Lincolnshire where it is confined by overlying Jurassic strata. The total theoretical resources of the Limestone are estimated to be about 69 mgd; abstraction in 1965 amounted to some 22 mgd. (Knapp-USGS)
W70-04733

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
Louisiana Water Resources Research Inst., Baton Rouge.
For primary bibliographic entry see Field 04B.
W70-04856

GEOLOGICAL SUBSIDENCE,
Sullivan S. Marsden, Jr., and Stanley N. Davis.
Scientific American, Vol 217, No 6, p 93-100, June 1967.

Descriptors: *Land subsidence, *Injection wells, *Pumping, *Irrigation, *Oil reservoirs, Oil wells, Natural gas, Semiarid climates, Groundwater, California, Subsidence, Damages, Withdrawal, Compaction, Rocks, Structural geology, Instrumentation, Logging (Recording).
Identifiers: *San Joaquin Valley, (Calif).

The pumping of oil, gas or water from the ground often causes the overlying land to sink as porous soil compacts. This phenomenon, known as geological subsidence, was first noted at oil fields near Galveston, Texas, and Long Beach, California. These areas of subsidence are relatively small, however, when compared to the San Joaquin Valley region of California. Sinking has affected areas totalling 2500 square miles there. This is the result of forty years of intensive groundwater pumping for irrigation purposes. In some places the ground is subsiding at the rate of a foot a year and the land is more than 20 feet below its former level. The situation is aggravated by the fact that approximately 20% of all U.S. well water pumping occurs in the San Joaquin Valley. In oil and gas fields the water injection technique is used to prevent soil settling. Further research and investigation is necessary to find methods applicable to water removal areas. (Carr-Arizona)
W70-04908

2G. Water in Soils

FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
Herman Bouwer.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 243-251, 1967. 9 p, 3 fig, 12 ref.

Descriptors: *Infiltration, *Measurement, *Soil water movement, *Artificial recharge, *Water spreading, Moisture content, Soil moisture, Hydraulic conductivity, Sorption, Analog models, Model studies, Mathematical models, Hydraulic gradient, Permeameters, Piezometers.
Identifiers: Field hydraulic conductivity tests.

Recent developments for measuring essentially vertical hydraulic conductivity, K, in the zone between soil surface and the water table are discussed. Seepage meters are suitable for measuring K of bottom material (including impedance of clogged surfaces) and local infiltration rates and gradients in spreading basins. A newly developed permeameter-type device enables relatively rapid field measurement of K and the negative soil-water pressure whereby K undergoes its first reduction. The method is applicable to surface and subsurface soil layers and data are obtained for sorption as well as for desorption. Field experiences with the double-tube method are summarized and certain desirable design and operational features are presented. Relatively deep K-measurements can be made by determining infiltration rates and gradients at the bottom of auger holes and wells. Fast-reaching piezometers which enable pressure measurement shortly after insertion were developed for this purpose. A brief discussion is given of how the K-data obtained can be used in analytical, analog, or digital models for predicting total flow systems below spreading basins, including infiltration rates, or transmission losses from ephemeral streams. (Knapp-USGS)
W70-04607

WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
Texas A and M Univ., College Station. Water Resources Inst.
Charles W. Wendt.
Available from the Clearinghouse as PB-190 268, $3.00 in paper copy, $0.65 in microfiche. Technical Report No 24, Water Resources Institute, Texas A and M University, February 1970. 88 p, 3 tab, 40 fig, 32 ref. OWRR Project A-006-TEX.

Descriptors: *Evaporation, *Soil, *Soil water, *Lysimeters, Vapor diffusion, Unsaturated flow, Microclimate, Water balance, Energy balance.

Lysimeters of 'natural' soil cores were constructed for field study of evaporation. A total of 9 lysimeters were constructed which were designed for either visual or recorded readout of data. Either the combination method of van Bavel or the Bowen Ratio will provide a fair estimate of evaporation from a wet soil surface in the area. In general, the combination method tends to overestimate while the Bowen Ratio tends to underestimate evaporation. This is due to the fact that the combination method places a strong emphasis on this parameter. The conductivity of the Olton loam soil is very low at fairly low soil water pressures corresponding to high contents. This is an asset in preventing evaporation losses, but may be deterimental to crop production in that the crops need to develop extensive root systems to use the stored soil moisture. Evaporation within a cotton crop canopy following rains is related to the net radiation reaching the soil surface. After the surface dries, the moisture content of the soil surface is the limiting parameter. Crude soil applied to the wet soil surfaces of the lysimeters following rains suppressed evaporation immediately following the rains.
W70-04685

MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
Hawaii Univ., Honolulu. Water Resources Research Center.
For primary bibliographic entry see Field 05G.
W70-04688

A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
North Dakota State Univ., Fargo. Dept. of Soils.
For primary bibliographic entry see Field 03C.
W70-04985

2H. Lakes

AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
Duke Univ., Durham, N. C. Dept. of Zoology.
Robert L. Kendall.
Ecological Monographs, Vol 39, No 2, p 121-176, Spring 1969. 56 p, 18 fig, 5 tab, 167 ref, append.

Descriptors: *Ecology, *Lakes, *Paleoclimatology, Quaternary period, Paleohydrology, Paleolimnology, Limnology, Climatology, Vegetation effects, Fish, Water quality.
Identifiers: Lake Victoris (East Africa).

The ecological history of Lake Victoria, east Africa, was studied using historical, sedimentary, chemical, fossil, and pollen data. During the last 12,000 years the overall sedimentation rate has been essentially constant. Lake Victoria was without an outlet from before 14,500 B.P. until about 12,000 B.P. During this time the lake was chemically more concentrated than it is today, and carbonate minerals were precipitated. From 12,000 to 10,000 B.P. the lake probably had an outlet. For a short period around 10,000 B.P. the lake again became closed. Since that time it has drained northward via the Nile River. Changes in forest vegetation are best explained by changes in rainfall, but during the last 3,000 years human forest clearance has interfered. The climatic changes inferred for the northern Victoria basin--dry from 14,500 to 12,000 B.P., moderately wet from 12,500 to 10,500 B.P., moderately dry from 10,500 to 9,500 B.P., wet from 9,500 to 6,500 B.P., and slightly drier or with a more seasonal rainfall after 6,500 B.P.--correlate very well with those already established for montane and rift valley location in east Africa. The greater chemical concentration of Victoria during part of its history may have forced the fish toward the more dilute tributaries, segregating the populations. (Knapp-USGS)
W70-04597

AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
Bureau of Sport Fisheries and Wildlife, Amherst, Mass.
For primary bibliographic entry see Field 07C.
W70-04651

LAKE EUTROPHICATION -- A NATURAL PROCESS,
Geological Survey, Albany, N.Y.

For primary bibliographic entry see Field 05C.
W70-04721

HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
Warsaw Univ. (Poland). Dept. of Physical Geography.
Jadwiga Stasiak.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 847-851, 1966. 5 p, 2 fig, 11 ref.

Descriptors: *Lakes, *Lake stages, *Pleistocene epoch, *Paleolimnology, Glacial drift, Ponds, Geomorphology, Limnology, Bogs, Lake basins, Lake beds.
Identifiers: *Poland.

Areas of Poland covered by the last glacier are rich in lakes which were established by melting of blocks of dead, buried ice. The lake age depends upon the thickness of the material covering the ice. The majority of lakes began to appear already in Allerod as shallow, extensive flood waters. In the Holocene, Preboreal and Boreal periods occurred the further formation and deepening of lakes under the influence of ice melting. Some lakes in outwash areas where the thickness of outwash material is considerable, appear only in climatic optima. In the Holocene, there occurred considerable fluctuations of the groundwater table resulting from climatic variations. The fluctuations caused the decay of a great number of smaller basins. (Knapp-USGS)
W70-04754

CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
Research Inst. for Water Resources Development, Budapest (Hungary).
L. Bendefy.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 852-864, 1966. 13 p, 7 fig, 10 ref.

Descriptors: *Water levels, *Lakes, *Dams, *Spillways, *Regulation, Water level fluctuations, Reservoir operation, Geomorphology, High water mark, Low water mark.
Identifiers: *Lake Balaton (Hungary).

Geomorphology, archeologic evidence, and measurements of past water heights were used with historical records to compile a history of water levels of Lake Balaton, Hungary. The depth in preneolithic times was 106-107 m above Adriatic sea level. Neolithic people built a dam to raise the level to 109 m for defensive purposes. The Romans build a sluice to control the level at 104.5 m. Since that time, the level has been maintained at heights between 107 and 112 m by Hungarians, with high levels in response to invasions and threats of invasions, and low levels for more exposure of farm lands in times of peace. The present level is controlled by a concrete lock at 104.5-105.8 m. (Knapp-USGS)
W70-04755

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
Research Inst. for Water Resources Development, Budapest (Hungary).
K. Szesztay.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 894-905, 1966. 12 p, 8 fig, 3 tab, 2 ref.

Descriptors: *Lakes, *Surveys, *Statistical methods, Hydrologic data, Hydrologic budget, Data collections, Water resources development, Water management (Applied), Water quality, Water supply, Limnology.
Identifiers: Hungary.

Considering national and international aspects of lake water resources, two kinds of inventories are required: (1) a general survey on all lakes larger than a chosen lower limit, using morphometrical data that can be determined mostly from general geographical maps; (2) an additional survey limited to hydrologically well-studied lakes, containing all basic hydrological data. Results of a detailed national inventory in Hungary show that the number of mapped lakes varies with the chosen lower limit according to a well-defined statistical pattern. As very tentative values for reasonable lower extension limits, 0.5 to 5 hectares can be recommended in case of detailed local surveys, 10 to 50 hectares in case of general countrywide surveys, and 100 to 200 sq km in case of continental or global surveys. The use of the central files comprising inventory results can be facilitated by preparing indexes, maps and diagrams following the viewpoints of various possible application fields. Comparing inventory results with climatological and geomorphological data, general conclusions can be drawn on water balance and stage-regime conditions. (Knapp-USGS)
W70-04757

ON WATER BUDGET LAKE CLASSIFICATION,
Leningrad State Univ. (USSR). Limnology Lab.
B. B. Bogoslovsky.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 910-917, 1966. 8 p, 2 fig, 1 tab, 13 ref.

Descriptors: *Limnology, *Lakes, *Surveys, *Classification, Inflow, Streamflow, Water levels, Water supply, Water resources development, Water level fluctuations, Hydrologic budget.
Identifiers: *USSR, Lake classification.

A lake classification is proposed based on the correlation of water budget components. In the USSR, two groups of lakes are based on the correlation of the components of the expenditure part of water budget: (1) 'stokovye' - with outflow predominance; and (2) 'isparjayuschie' - with evaporation predominance. Within every group the lakes are subdivided into types according to the character of the income budget part: 'pritochny' - with the inflow predominance from rivers: 'dohzdevoj' - with atmospheric precipitation predominance to the lake surface and 'neitralny' - with equal quantity of water coming from rivers and atmospheric precipitation. The lake designation in the classification includes the name of the group and the type. Areal distribution of lake types reveals a geographical zonality, both latitudinal and vertical. The lakes of the first type are typical of the zones with high moisture, the lakes of the second type, of arid zones. Water budgets of the lakes with a great drainage basin and a small surface show predominance of inflow and outflow from the lake. The lakes with a large surface and a small drainage basin differ by the predominance of evaporation and atmospheric precipitation. On the basis of the proposed classification a territorial division of lakes of the USSR was performed. (Knapp-USGS)
W70-04758

THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
Royal Danish School of Pharmacy, Copenhagen. Dept. of Botany.
E. Steemann Nielsen, and Erik G. Jorgensen.
Physiologia Plantarum, Vol 21, No 3, p 647-654, 1968. 2 tab, 20 ref.

Descriptors: *Plankton, *Algae, Light intensity, Temperature, Primary productivity, Surfaces, Arctic, Enzymes, Chlorophyll, Photosynthesis, Chlorella, Grazing, Zooplankton, Diatoms, Respiration, Pigments, Oceans, Organic matter, Diurnal, Latitudinal studies.
Identifiers: Photooxidation, Chlorella vulgaris, Chlorella vulgaris (Columbia), Chlorella pyrenoidosa, Chlorella saccharophila, Chlorella ellipsoidea, Chlorella luteoviridis, Skeletonema costatum, Physiological adjustment, Asterionella formosa, Cyclotella Meneghiniana, Photic zone, Helsingor (Denmark), Salino-cline.

Adaptation (physiological adjustmant) of plankton algae, in natural states, to different light intensities and temperatures is described. Although different species vary in extent of adaptation, they all adapt to some degree, and adaptation is significant for plankton populations at all depths. Shade adaptation of algae in the lower part of the photic zone is often of minor importance to the integral primary production per unit of surface, except on occasions when the bulk of the algae is found in this lower part. It is shown that the I-sub-k (a light intensity defining onset of light-saturated photosynthesis) of surface plankton during summer in the Arctic is high despite low temperatures due to increase of the enzyme quantities per cell. Daily fluctuations in I-sub-k are partially due to photooxidation and partially because the periods for the production of chlorophyll and photosynthetic enzymes are mutually displaced. Despite daily fluctuations in I-sub-k, the difference between 'sun' and 'shade' phytoplankton is distinct. The diurnal variation in photosynthetic activity of phytoplankton may take place especially at low latitudes, and near the surface; and to some extent at higher latitudes, and in lower photic zone. (Jones-Wisconsin)
W70-04809

EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
Schoell and Madson, Inc., Hopkins, Minn.
James R. Orr.
Water and Sewage Works, Vol 115, No 3, p 97-101, 1968. 2 fig, 2 tab, 10 ref.

Descriptors: *Eutrophication, *Minnesota, Recreation, Sewage disposal, Water pollution, Pollution abatement, Coliforms, Water quality, Phosphorus, Nitrogen, Flow, Chemical analysis, Nutrients, Effluents, Algae, Weeds, Carbon dioxide, Vitamins, Nitrates, Inorganic compounds, Surface runoff, Underflow, Precipitation (Atmospheric), Drainage, Fertilizers, Farm wastes, Soil erosion, Frozen ground.
Identifiers: Lake Minnetonka (Minn), Minneapolis-St Paul (Minn).

The greatest source of nutrients to Lake Minnetonka, one of Minnesota's best known lakes, is sewage treatment plant effluent. A major part of the problem would be solved by removing nutrients from effluents or suppressing sewage effluent discharge. Loss of large quantities of wastewater outside the watershed could aggravate the problem of maintaining lake level. Another approach may be control of excessive weed and algae production by chemical treatment or mechanical harvesting, however, continued use of algicides may eventually have a toxic effect on fish and other aquatic life; mechanical harvesting is impractical. Advanced waste treatment of sewage discharged to lake, with emphasis on removal of phosphorus should be considered. Miscellaneous nutrient sources, other than sewage plant effluent, represent approximately 2/3 total nitrogen and approximately 1/5 total phosphorus inflow. Watershed dwellers can minimize these sources by preventing decaying vegetation being washed into the lake by rainfall, discontinuing commercial and manure fertilizer usage, and practicing soil erosion control. Municipalities can assist by keeping public lands clean, locating waste dumps to avert drainage into the lake, eliminating soil absorption sewage disposal facilities adjacent to lake, and by publicizing the problem. (Jones-Wisconsin)
W70-04810

SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
Wisconsin Univ., Madison. Dept. of Meteorology.
Alison Lathbury, Reid Bryson, and Bernhard Lettau.
Limnology and Oceanography, Vol 5, No 4, p 409-413, 1960. 3 fig, 1 tab, 3 ref.

Descriptors: *Lakes, *Currents (Water), *Hypolimnion, Wisconsin, Thermal stratification, Seiches, Turbulence, Statistical analysis, Hydrography.
Identifiers: *Physical limnology, *Lake Mendota (Wis), 'Free drag' method, Internal seiches, 'Surface' seiches, Hypolimnetic currents, Surface currents, Hydrokinetics.

Data are presented regarding some 2000 current measurements made by 'free drag' method during a ten year period in Lake Mendota, Wisconsin. Frequency distributions of current velocities are presented for 8 depths from entire lake, but predominantly from southwestern portion. Currents at 2-meter depth are anomalous in that their mean and modal velocity exceeds expected values, and that frequency of currents in interval, 0-0.99 centimeters/second, is smaller than expected. Data suggest operation of influences other than usual wind drift mechanism, possibly a larger than expected role for seiche circulation. Deep water currents, particularly in medium-sized stratified lakes, have been thought to result from internal seiches. Seiches in Lake Mendota typically have range of 2-4 millimeters; amplitude, 1-2 millimeters; period, 25-26 minutes; and induced currents, 0.1 centimeter/second at node. Observations of hypolimnetic currents, integrated over 24 hours to include numerous seiche periods, indicate existence of steady motion below thermocline, which are independent of seiches. Best interpretation regards hypolimnetic currents in Lake Mendota as quasi-steady with superimposed seiche-induced variations. Turbulence, also, will not explain observed currents, but problem remains of distinguishing between magnitude of such currents due to thermally induced pressure gradients, and that due directly to wind. (Eichhorn-Wisconsin)
W70-04812

PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
Freshwater Biological Association, Ambleside (England).
J. F. Talling.
Journal of Ecology, Vol 54, p 99-127, 1966. 11 fig, 70 ref.

Descriptors: *Photosynthesis, *Plankton, *Aquatic life, Lakes, Density stratification, Light penetration, Temperature, Depth, Light, Photoperiodism, Oxygen, Aquatic population, Pigments.
Identifiers: *Carotenoids, Chlorophyll a, Photosynthetic mechanism, Photosynthetic-depth profiles, Photoxidation, Asterionella formosa, Windermere Basin (England), Blelham Tarn (England).

Gross photosynthesis rates of four populations of Asterionella formosa were determined from exposures in lakes and laboratory during different seasons of the two successive years. Despite differences between the depth of lakes and timing of population maxima, photosynthetic characteristics and pigments remained similar. Vertical distribution of organisms took place rapidly after thermal stratification. Light was the chief factor in the physiological differentiation in a silica-deficient medium. Deeper cells exhibited a decreased carotenoid:chlorophyll a ratio and contracted chromatophores. No diurnal variation in photosynthetic capacity or pigments was observed. The photosynthesis in populations stratified at different depths could be estimated from the distribution of photosynthetic capacity per unit water volume and the depth-profile rates of photosynthesis of homogenous material. (Wilde-Wisconsin)
W70-04814

INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
Hull Unov. (England). Dept. of Botany.
R. Goulder.
Oikos, Vol 20, No 2, p 300-309, 1969. 5 fig, 3 tab, 31 ref.

Descriptors: *Phytoplankton, Productivity, Diurnal, Oxygen, Carbon, Light intensity, Ponds.
Identifiers: *Macrophytes, Ceratophyllum demersum, Potamogeton natans, Vertical distribution, Carbon-14, Carbon fixation, Chlorophyll a, Selenium cell, Northeastern England, England.

As determined by carbon-14 analyses, the annual production of phytoplankton in a small pond of northeastern England constituted 1100 grams carbon/ square meter. The gross annual yield of Ceratophyllum demersum in the same basin, as measured with the diurnal oxygen method, was 600 grams carbon/square meter. The high summer macrophyte productivity followed the maximum spring increment of the phytoplankton. Another pond, with a lesser macrophyte density, had a high summer phytoplankton biomass but its annual production of only 500 grams carbon/square meter, was below that of the first basin. The reason for the summer suppression of phytoplankton in the first pond is attributed to greater shading exerted by Ceratophyllum demersum compared with Potamogeton natans. Phytoplankton yield showed a relationship with the vertical distribution of chlorophyll. (Wilde-Wisconsin)
W70-04818

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
Wisconsin Univ., Madison.
J. H. Beuscher.
Eutrophication: Causes, Consequences, Correctives, Printing and Publishing Office, National Academy of Sciences, Washington, DC, 1969. p 520-527.

Descriptors: *Lakes, *Eutrophication, *Land use, *Shore protection, *Zoning, *Regulation, Water pollution, Aesthetics, Public Health, Wisconsin, Legislation, Riparian rights, Competing uses, Streams, Flood plain zoning, Wetlands, Planning, Urbanization, Inter-agency cooperation, Legal aspects, Political aspects, Water law, Water policy, Local governments, Public rights, Ethics.
Identifiers: *Cultural eutrophication, Multiple use, Environmental quality, Wisconsin Water Resources Act, Shoreland Protection Ordinance, University of Wisconsin, Model legislation, Public education.

Increasing multipurpose use of lake and stream shorelands has raised diverse and complex problems, not only regarding eutrophication abatement, but also in the areas of public health, aesthetics, and land-use ethics. It is unlikely that normal economic forces will solve shoreland problems; patient educational and voluntary action programs coupled with legal controls are vitally required. Legalistically, shoreland zoning and regulation must consider ownership of lake bottoms, and relative merits of private property versus public interest. Consideration of regulatory impact on private development must include: its effect upon market value of owner's land; damaging effect of development upon others; extent of the public interest and whether regulation meets that need. Research results to document such criteria are often lacking, but groups of specialists, operating as a team, can identify 'indicators of danger' and thus establish a basis for regulation. Based on these principles, a model County Shoreland Protection Ordinance has been developed at University of Wisconsin, Madison, which incorporates following features: zonning controls; subdivision controls; sanitation controls, tree-cutting restrictions; controls on filling, grading, and creating artificial waterways. A list of requirements for future success of such programs is included. (See Vol. 3, No. 10, Field 5C, W70-03975). (Eichhorn-Wisconsin)
W70-04820

PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
North Dakota State Univ., Fargo. Div. of Natural Sciences.
J. J. Peterka.
Available from the Clearinghouse as PB-190 356, $3.00 in paper copy, $0.65 in microfiche. Research Project Technical Completion Report, North Dakota, Feb 1970. OWRR Project A-011-NDAK.

Descriptors: *Water chemistry, Reservoirs, *Phytoplankton, *Zooplankton, Benthic invertebrates, Primary and secondary productivity, Ecology, North Dakota eutrophication, Limnology.
Identifiers: Lake Ashtabula Reservoir.

Lake Ashtabula, a 5,430-acre reservoir in southeastern North Dakota, was found to be a highly productive impoundment. Chemical, physical, and plankton samples were taken in 1967-68; benthic invertebrates in 1967. Largest chemical exchanges occurred from February-June when large water volumes also entered and left the reservoir. Large amounts of phosphates, inorganic nitrogen and total iron entered during March. Phosphates, total iron and total alkalinity were retained in the reservoir from June 1967 to June 1968, whereas sulfates decreased. The order of appearance of maximum numbers of zooplankton was similar in 1967-68 with Cyclopoida first, then Daphnia pulex, Asplanchna, Diaptomus, Daphnia galeata mendotae, Bosmina, Cereodaphnia, Chydorus, and a fall pulse of D. pulex. Chaoborus was found only in 1967; Leptodora in 1968. Daphnia comprised 84% of total zooplankton dry weight standing crop in 1967 and 81% in 1968; copepods 14% in 1967 and 17% in 1968. The average dry weight daily standing crop of D. pulex was 1110 in 1967 and 2851 mg/ (sq m) in 1968; of D. g. mendotae was 294 in 1967 and 7.2 mg/ (sq m) in 1968. Daphnia annual net production averaged 113.1 and 71.3 mg/ (sq m)/sq day in 1967 and 1968, respectively; its calculated turnover time from January-December was 11.8 days for 1967 and 40.0 days for 1968. In both years, plytoplankton at Station 2 included a March-June pulse of largely nannoplankton diatoms, Stephanodiscus spp., and Cyclotella spp., followed by microplankton Stephanodiscus niagarae, Asterionella formosa and Cryptomonas spp. from June-July. Aphanizomenon holsaticum dominated from July-November. In 1967 and 1968, respectively, Aphanizomenon comprised 86.3 and 92.9%, diatoms 13.4 and 2.97%, and other phytoplankters 0.3 and 4.2% of total algal weight from January-December. At Station 2 from January-December 1967 and 1968, the average daily algal weight standing crop was 176.5 and 288.6 g/ (sq m), and average daily gross photosynthesis was 4.10 and 6.75 O2/ (sq m)/day, respectively. From March-November 1968, 1.0 microgram chlorophyll 'a' = 1.0 cu mm algal cells. The correlation coefficient of silicon with loge total diatom numbers from 3 June-20 October 1968 was $r = 0.51$ ($P = 0.05$). The average standing crop of benthic invertebrates at Station 2 from April-August 1967 was 2,483 individuals weighing 10.9 g/ (sq m), with 52% by number and 76% by weight found in the 0-3 m depth zone; 42% by number and 21% by weight in 3-8 m; and 6% by number and 3% by weight in the 8-12 m depth zone.
W70-04855

HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
Moscow State Univ. (USSR).
Z. V. Aleuchinskaya, L. G. Bobdarev, and R. D. Zabirov.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 841-846, 1966. 6 p, 2 fig, 12 ref.

Descriptors: *Lakes, *Paleolimnology, Geomorphology, Water quality, Depth, Productivity, Ecology, Pleistocene epoch, Lake morphology, Lake stages, Water levels.
Identifiers: *USSR, Lake Issyk-Kul, Paleontology.

The history of the origin and development of Lake Issyk-Kul, one of the largest lakes in the Soviet Union, is described. When solving problems of paleolimnology, geological-geomorphological,

geochemical, paleontological, and isotopic methods were used. The investigations described a complicated history of the Lake Issyk-Kul and repeated fluctuations of its level, mainly due to climatic changes. (Knapp-USGS)
W70-05021

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
Zuider Zee Works (Netherlands). Hydrology Section.
For primary bibliographic entry see Field 08A.
W70-05027

2I. Water in Plants

RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
Forest Service (USDA), Cadillac, Mich. North Central Forest Experiment Station.
For primary bibliographic entry see Field 02C.
W70-04717

PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 05C.
W70-04902

EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
Oregon State Univ., Corvallis. School of Forestry; and Oregon Agricultural Experiment Station, Corvallis.
J. Zavitkovski, and W. K. Ferrell.
Botanical Gazette, Vol 129, No 4, p 346-350, December 1968. 3 fig, 1 tab, 19 ref. NSF Grant G-9576.

Descriptors: *Drought resistance, *Douglas fir trees, *Respiration, *Transpiration, *Photosynthesis, Turgidity, Droughts, Arid lands, Moisture stress, Plant physiology, Environment, Seeds, Soil moisture, Soil-water-plant relationships, Moisture tension.
Identifiers: *Seedlings.

Douglas-fir seedlings were grown from seed collected at two sites of widely differing habitat. One group of seed was gathered from an area of high precipitation but limited summer rain, the other from a dry area with a prolonged summer drought. Rates of respiration, transpiration, and photosynthesis were determined under variable soil-moisture stress conditions. After 1 atm of stress was reached photosynthetic rates declined sharply. Mesic site seedlings had higher respiration and transpiration rates at both high and low soil moisture tensions. Seedlings from the drier environment had higher rates of photosynthesis at high relative turgidities and lower rates at low relative turgidities than seedlings from the wetter site. Relative turgidity of xerophytic seedlings varied less than that of mesophytic seedlings over a wide range of soil-moisture tensions. It appears that seedlings from the xeric site have adapted to the severe drought conditions of their arid environment. (Carr-Arizona)
W70-04909

DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Irrigation Research Lab.
J. H. Palmer.
Agricultural Meteorology, Vol 4, No 1, p 39-54, January 1967. 7 fig, 2 tab, 20 ref.

Descriptors: *Cotton, *Irrigation effects, *Crop response, *Moisture stress, *Diurnal, Fluctuation, Biorhythms, Plant physiology, Air temperature, Semiarid climates, Soil-water-plant relationships, Thermal stress, Temperature, Leaves, Soil moisture, Furrow irrigation, Canopy, Measurement, Summer, Winter.
Identifiers: *Leaf temperature, *Boll temperature, *Australia, Thermocouples.

Cotton plants under furrow irrigation were studied to determine the effect of withholding irrigation water upon leaf and boll temperature. In all of the experiments the leaf temperature of irrigated plants tended to level off toward the end of the morning, but the temperature of non-irrigated plants continued to increase at the early morning rate. For both moisture regimes, the plants cooled rapidly following midafternoon and were cooler than the ambient air by early evening. In a comparison of irrigated and non-irrigated plants, it appeared that boll temperature is more sensitive than leaf temperature to soil moisture stress. (Carr-Arizona)
W70-04912

2J. Erosion and Sedimentation

SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
Woods Hole Oceanographic Institution, Mass; and Williams Coll., Williamstown, Mass. Dept. of Geology.
Frank T. Manheim, Robert H. Meade, and Gerard C. Bond.
Science, Vol 167, p 371-376, January 1970. 6 p, 4 fig, 3 tab, 24 ref.

Descriptors: *Suspended load, *Sea water, *Atlantic coastal plain, *Water pollution sources, Surveys, Sampling, Currents (Water), Ocean currents, Sediment distribution, Sediment load.
Identifiers: Atlantic continental margin.

Appreciable amounts of suspended matter over 1.0 milligram per liter in surface waters are restricted to within a few kilometers of the Atlantic coast. Particles that escape estuaries or are discharged by rivers into the shelf region tend to travel longshoreward rather than seaward. Suspended matter farther offshore, chiefly amorphous organic particles, totals 0.1 milligram per liter or less. Soot, fly ash, processed cellulose, and other pollutants are widespread. (Knapp-USGS)
W70-04552

SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
Soil Conservation Service, East Lansing, Mich.
J. R. Thompson.
Journal of Soil and Water Conservation, Vol 25, No 1, p 8-10, January-February 1970. 3 p, 3 fig, 4 tab, 4 ref.

Descriptors: *Soil erosion, *Urbanization, *Michigan, Cities, Runoff, Soil conservation, Land use, Roads, Sediment yield, Construction, Road construction, Sediment control.
Identifiers: Detroit (Mich).

A study was made in the Detroit metropolitan area to evaluate the rates and amounts of erosion from urban construction sites. In the summer of 1968, 2.1% of an urban zone was under development. This zone produced about the same amount of eroded soil material as the remaining 97.9% of the area. Erosion from the developing areas averaged 69 tons per acre per year, compared with an overall average erosion rate for the metropolitan area of about 3.0 tons per acre per year and an overall average erosion rate for southeast Michigan of 2.6 tons per acre per year. (Knapp-USGS)
W70-04557

TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957-65, A COMPILATION,
Geological Survey, Lawrence, Kans.
C. D. Albert.
Kansas Water Resources Board Bulletin No 10, June 1969. 8 p, 1 fig, 1 tab, 8 ref.

Descriptors: *Sediment load, *Streams, *Kansas, *Sediment discharge, Sediment transport, Bed load, Suspended load, Discharge (Water), Streamflow, Particle size, Data collections, Hydrologic data.
Identifiers: Sediment sampling.

Computed total sediment discharges for selected streams in Kansas are presented. The suspended load is computed from analyses of depth-integrated samples, but the design of the suspended-sediment sampling equipment prevents sampling within about 0.3 foot of the stream bottom. In a sand-bed stream the sediment concentration normally is higher and the particle size larger in the unsampled zone than in the sampled zone. Thus, the total sediment discharge of many streams may be appreciably greater than that indicated by suspended-sediment samples alone. Several different formulas and procedures have been used to determine the total sediment discharge of streams. A procedure developed by H. A. Einstein (1950) was modified by Colby and Hembree (1955) and was simplified again by Colby and Hubbell (1961). The latter modification, which includes graphical methods to eliminate cumbersome computations, was used to obtain the results shown in the data tabulation. (Knapp-USGS)
W70-04560

THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
Akademiya Nauk SSSR. Institut Okeanologii.
For primary bibliographic entry see Field 02L.
W70-04566

MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
Kyoto Univ., (Japan). Disasters Prevention Research Inst.
Yoshito Tsuchiya.
Bulletin Disaster Prevention Research Institute, Vol 19, Part 1, Paper 152, p 31-44, August 1969. 14 p, 8 fig, 1 photo, 10 ref.

Descriptors: *Erosion, *Sediment transport, *Sands, *Saltation, Alluvial channels, Turbulent flow, Streamflow, Mathematical studies, Mathematical models.
Identifiers: Movable beds.

Most of the saltating sand particles on a granular bed in a turbulent stream successively continue saltation after initial motion. In this paper, such a saltation motion is defined as successive saltation. A theory of the successive saltation of a single sand particle on a granular bed is proposed on the basis of the equation of motion for saltation and the dynamic characteristics of collision between a saltating sand particle and bed sand particles. The theoretical relationships for the saltation height and distance and for their distribution characteristics are in good agreement with the results of experiments. (Knapp-USGS)
W70-04582

FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
Geological Survey, Washington, D.C.
E. J. Helley.
Report available for sale by Superintendent of Documents, U S Government Printing Office, Washington, D C 20402 - Price 35 cents. Geological Survey Professional Paper 562-G, p G1-G19, 1969. 19 p, 15 fig, 2 tab, 26 ref.

Descriptors: *Sediment transport, *Bed load, *Alluvial channels, Hydraulics, Movement, Scour, Erosion, Tractive forces, Velocity, Streamflow, Sedimentation.
Identifiers: Particle movement initiation.

In a field sediment transport study, more than two-thirds of measurements of bed velocity necessary to initiate motion of coarse natural particles agree within 20% of those velocities predicted from theory. The theory is based on balancing turning moments of the fluid forces of drag and lift with the resisting moment of the submerged particle weight. Initial motion seems to depend more on size and shape than on specific gravity or orientation angle. In fact, shape differences almost completely compensate for differences in specific gravity from 2.65-3.00 and at orientation angles from 0 deg-25 deg. Bed velocities necessary to initiate motion of coarse bed material in Blue Creek are equaled or exceeded about 5% of the time. This fact and changes in channel topography and cross-sectional area emphasize the ability of perennial mountain streams to transport coarse bed material frequently. (Knapp-USGS)
W70-04599

TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
For primary bibliographic entry see Field 02L.
W70-04696

ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
Marathon Oil Co., Littleton, Colo.; and Scripps Institution of Oceanography, La Jolla, Calif.
For primary bibliographic entry see Field 05B.
W70-04707

A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
Centre Universitaire Marseille-Luminy, Marseille (France). Geology Lab.
Pierre Weydert.
Sedimentology, Vol 13, No 1-2, p 71-83, October 1969. 13 p, 5 fig, 4 tab, 17 ref.

Descriptors: *Particle shape, *Sediments, *Analytical techniques, *Sieves, *Sieve analysis, Instrumentation, Separation techniques, Measurement, Sedimentology, Statistical methods, Sampling.
Identifiers: Particle shape analysis, Sphericity, Roundness.

A new method is presented to determine the sphericity of sand particles with sedimentary analysis. Two different sieves are used: one with open squares; the other with circular openings. Experimentation shows that particles crossed the open-square sieves in diagonal positions. A sediment, which is composed of subspherical particles, is represented by two cumulative curves on the same graph. If the sediment is very angular, the two curves are disconcerted, while if the sediment is subspherical, the difference between the two curves is maximum. The sphericity values obtained are comparable with those of visual charts. (Knapp-USGS)
W70-04731

DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
State Inst. of Hydrology and Meteorology, Krakow (Poland).
J. Cyberski.
English summary included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 741-746, 1966. 6 p, 2 fig, 8 ref. English summary included.

Descriptors: *Reservoir silting, *Forecasting, *Sedimentation, Bed load, Suspended load, Provenance, Sediment yield, Silts, Erosion, Sediment transport.
Identifiers: *Poland, Dunajec River.

A method to determine the silting of reservoirs is presented and applied to the Roznow Reservoir, Poland. The method is based on many years of observations and measurements of water stage, discharge and silt charge of the Dunajec River, as well as special research on the damage of the shores, and the bed load coming from small streams. The main sources of sediment supplying the reservoir are the suspended and bed loads of the Dunajec River and of the small streams flowing into the reservoir. In the total amount of the silting the participation of the solid transport from individual sources is variable. The basic component is the suspended load of the Dunajec River; a small percentage is due to the bed load from the streams flowing into the reservoir and the bed load coming from Dunajec river. Only 1 percent originates in the bed load from the shore denudation. (Knapp-USGS)
W70-04751

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
Corps of Engineers, Rock Island, Ill., Iowa Univ., Ames, and Argicultural Research Service, Columbia, Mo.
C. W. Farnham, C. E. Beer, and H. G. Heinemann.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 747-758, 1966. 12 p, 2 fig, 2 tab, 13 ref.

Descriptors: *Reservoir silting, *Forecasting, *Sedimentation, *Statistical methods, Regression analysis, Iowa, Missouri, Erosion, Sediment transport, Land management, Provenance, Loess, Missouri River.
Identifiers: *Missouri River basin.

Detailed field surveys were made of existing reservoirs in the loessial hills of western Iowa and northwestern Missouri to determine the rate of sediment accumulation. Additional data were secured to evaluate the variables associated with reservoir trap efficiency, with delivery of sediment to reservoir and with gross erosion from the contributing watershed area. Through the use of multiple regression techniques, the rate of sediment deposition in the reservoirs was expressed as a function of computer gross erosion and measured reservoir and watershed variables. The results show that the amount of sediment deposited in the reservoir is highly correlated with the computed gross erosion. The remaining variation was explained as a function of variables defining the reservoir trap efficiency and watershed delivery ratio. A greater insight was obtained of the importance of land management and the interaction of reservoir and watershed variables as they affect reservoir sedimentation. (Knapp-USGS)
W70-04752

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
Agricultural Research Service, Columbia, Mo. Soil and Water Conservation Div., and Missouri Univ., Columbia. Dept. of Zoology.
H. G. Heinemann, D. L. Rausch, and R. S. Campbell.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 769-779, 1966. 11 p, 5 fig, 1 tab, 9 ref.

Descriptors: *Reservoir silting, *Forecasting, *Sedimentation, *Surveys, Water quality, Thermal stratification, Silts, Clays, Model studies, Water circulation, Sediment transport, Particle size, Solutes, Provenance, Reservoir design.
Identifiers: *Ashland Lake (Missouri), Channel reservoirs.

Ashland Lake in central Missouri is a channel-type reservoir that was built in 1937 with a capacity of about 346,000 cubic meters. Its drainage area is 979 hectares. A study of its sedimentation was undertaken to provide essential design information. Detailed reservoir sedimentation surveys were made in 1949, 1951, 1955 and 1962. The distribution of sediment in the vertical and in the horizontal planes remained fairly constant between surveys. The particle-size distribution of the deposited sediment was found to vary, depending on the distance from the dam. The volume-weight of the sediment increased with depth in the deposit and decreased with percent clay. Physical and chemical measurements of the lake water show that Ashland Lake is stratified thermally May through October, confining circulation to the upper one-third of the lake. Water turbidity may reach 200 ppm (platinum wire). Concentrations of cations are less than amounts considered effective in flocculation of clay particles. (Knapp-USGS)
W70-04753

LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
Research Inst. for Geology and Biology. Wilhelmshaven (West Germany).
H. E. Reineck.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 191-206, 1967. 16 p, 32 fig, 3 tab, 43 ref.

Descriptors: *Sedimentary structures, *Sediments, *Beaches, *Mud flats, Continental shelf, Sedimentation rates, Provenance, Ripple marks, Sand waves, Sedimentation, Sands, Clays, Marshes.
Identifiers: *North Sea, Laminated sand, Ripple bedding, Lenticular bedding, Laminated bedding, Salt marsh.

Deposits of a particular environment are influenced by the type of available sediments, physical processes and their intensity, rate of sedimentation, and biogenetic factors. Sedimentary structures show the nature of water movement. For example, horizontal silty-clay lamellae are found in areas with little water movement whereas cross-bedded sands are a result of greater water movement. The characteristics of the following sedimentary structures are discussed and illustrated: (1) laminated sand; (2) ripple bedding; (3) lenticular bedding; (4) fine rhythmically laminated bedding; (5) coarse rhythmically laminated bedding; (6) mud deposits; (7) salt marsh or flood deposits; and (8) bioturbate structures. The distribution of sedimentary structures on salt marsh, tidal flat, sand flat, shore area and inshore to shelf area is given. (Carstea-USGS)
W70-04994

THE ONTOGENY OF A SALT MARSH ESTUARY,
Woods Hole Oceanographic Institution, Mass.
For primary bibliographic entry see Field 02L.
W70-04998

EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.
For primary bibliographic entry see Field 02L.
W70-05000

REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
Australian National Univ. (Canberra).
For primary bibliographic entry see Field 02L.
W70-05001

SEDIMENTS OF YAQUINA BAY, OREGON,
Oregon State Univ., Corvallis. Dept. of Oceanography.
L. D. Kulm, and John V. Byrne.

In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 226-238, 1967. 13 p, 12 fig, 13 ref. ONR Contract Nonr 1286 (10).

Descriptors: *Sediments, *Sedimentation, *Oregon, *Bays, Estuaries, Deposition (Sediments), Minerology, Particle size, Provenance, Sands, Sediment transport, Beaches, Mixing, Salinity, Shoals, Dredging, Sedimentation rates.
Identifiers: Yaquina Bay (Oregon).

Marine, fluviatile and marine-fluviatile deposition were defined in Yaquina Bay on the basis of sediment texture and mineralogy. Seasonal sedimentation, sources of recent sediments, and transport of marine sand from adjacent ocean beaches are described. Quantitative information about salinity mixing, shoaling, rates of deposition, source of shoaling material, and effects of improvement works on sediment deposition along the adjacent ocean beaches is given. Known areas of shoaling occur on the bar, in the main channel, and in the turning basin. Estimated average rate of deposition in the dredged channel is 9 inches per year. (Carstea-USGS)
W70-05002

THE SEDIMENTS OF CHESAPEAKE BAY,
Maryland Univ., Solomons. Natural Resources Inst.
Robert B. Biggs.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 239-260, 1967. 22 p, 26 fig, 8 tab, 49 ref.

Descriptors: *Sediments, *Sedimentation, *Water quality, *Bays, Water chemistry, Mineralogy, Clay minerals, Acidity, Color, Mixing, Oxidation, Reduction potential, Oxygen, Organic matter, Iron, Sulfur compounds.
Identifiers: *Chesapeake Bay, Pore water analysis, Sediment-water relationships.

Data from geological and oceanographic investigations of Chesapeake Bay show correlations between sediment types and dominating influences. A typical sequence of measured parameters and major influences of these parameters, both in the water column and the sediment, are presented. The parameters observed were pH, oxygen concentration, sulfate concentration, and Eh in the water column and pore water of the bed sediments. The color and water content of the sediments are also discussed. These parameters were related to the influences of mixing, oxidation, reduction, biological and bacterial activity, hydrotroilite concentration, and state of organic matter, iron, and sulfur species. (Carstea-USGS)
W70-05005

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
University of Southern California, Los Angeles. Dept. of Geological Sciences.
D. S. Gorsline.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 219-225, 1967. 7 p, 43 ref.

Descriptors: *Bays, *Coasts, *Sediments, *Sedimentation, *Estuaries, Lagoons, Sands, Beaches, Water circulation, Currents (Water), Tidal waters, Topography.
Identifiers: *Estuarine sedimentation, High-energy coasts, Low-energy coasts.

The general features of estuaries, estuarine sedimentation and sediment properties are discussed. Estuaries, bays, and lagoons are relatively new physical products and their age is not more than 3000 years. The major component of sediments in sand, and sedimentation patterns in these bodies of water are controlled by bottom topography and circulation. On high-energy coasts, estuaries are separated from the open sea by spits or beach deposits, and on low-and medium-energy coasts, estuaries are associated with coastal lagoons and barrier islands. Tidal currents are mainly responsible for circulation patterns in estuaries. The bulk of the sediment in estuaries is derived from seaward or coastal sources. Estuarine and bay sediments are relatively thin. (Carstea-USGS)
W70-05007

SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
Virginia Inst. of Marine Science, Gloucester Point; and Virginia Univ., Charlottesville. Dept. of Geology.
For primary bibliographic entry see Field 02L.
W70-05009

COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
Pennsylvania Univ., Philadelphia. Dept. of Geology.
George De Vries Klein.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 207-218, 1967. 12 p, 7 fig, 63 ref.

Descriptors: *Estuaries, *Sediments, Mud flats, Sedimentation, Marshes, Water circulation, Shallow water, Channels, Sedimentary structures, Barriers, Clays.
Identifiers: Tidal flat sedimentation.

Recent tidal flat sediments and sedimentation are described for Wadden-type flats and Fundy-type tidal flats. In the Wadden type, sedimentation occurs along soft-sediment coasts, whereas in the Fundy type it occurs along bedrock coasts. Geographic interrelationships are summarized for the following sedimentary environments in Wadden-type flats: salt marshes, high tidal flats, low tidal flats, and tidal channels. In Fundy-type flats, the following major sedimentary environments are discussed: Wave cut benches, estuarine clay flats, tidal flats in the lee of barrier islands, and tidal marshes. Ancient tidal flat deposits are described from the upper devonian of Belgium, the lower Devonian of England, and the Pennsylvanian of Illinois. Deposition of evaporites in the geological past required an estuarine circulation system and; therefore, it took place in mixed shallow marine environments. (Carstea-USGS)
W70-05010

QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
Florida Univ., Gainesville. Coastal Engineering Lab.
For primary bibliographic entry see Field 02L.
W70-05011

RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
Miami Univ., Fla. Inst. of Marine Science.
For primary bibliographic entry see Field 02L.
W70-05012

ORIGIN OF SEDIMENTS IN ESTUARIES,
Paris Univ. (France). Institut de Geographie.
For primary bibliographic entry see Field 02L.
W70-05013

ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
Woods Hole Oceanographic Institution, Mass.
For primary bibliographic entry see Field 02L.
W70-05016

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
Netherlands Inst. for Sea Research, Den Helder.
For primary bibliographic entry see Field 02L.
W70-05018

BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
State Hydrological Inst. (USSR).
For primary bibliographic entry see Field 04A.
W70-05022

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
Geological Survey, Tucson, Ariz.
For primary bibliographic entry see Field 02E.
W70-05023

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
Soil Conservation Service, Portland, Oreg. Engineering and Watershed Planning Unit.
Elliott M. Flaxman.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 824-838, 1966. 15 p, 4 fig, 3 tab, 4 ref.

Descriptors: *Reservoir silting, *Reservoir design, *Sediment transport, *Provenance, Statistical methods, Regression analysis, Aggradation, Runoff, Vegetation effects, Erosion, Rainfall-runoff relationships, Topography, Rainfall intensity.
Identifiers: *Sediment storage, Western U.S.

Predictions of sediment storage requirements are needed in the design of flood detention and water supply reservoirs in order to sustain an adequate capacity for intended purposes. In western United States the wide range in geologic, topographic, climatic, soils and vegetative conditions includes a number of factors which operate to increase or decrease rates of sediment deposition. To determine the influence of some watershed and reservoir variables on this problem, statistical procedures were used to analyze data from 30 locations in 9 states. Multiple regression and principal component regression with varimax rotation of the factor weight matrix were used. Variables include expressions for runoff, related vegetative response, rainfall intensity, topography, soil characteristics, the density of deposits, and trap efficiency of the reservoirs. The results of the analysis and predictive equations for sedimentation rates and for density of reservoir deposits are given. (Knapp-USGS)
W70-05024

SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
Soil Conservation Service, Washington, D.C. Engineering Div.
John W. Roehl.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 795-803, 1966. 9 p, 3 fig, 9 ref.

Descriptors: *Reservoir silting, *Farm ponds, *Reservoir design, Sediment yield, Sediment transport, Reservoir yield, Erosion, Runoff, Soil conservation, Soil erosion, Land management.
Identifiers: Soil Conservation Service.

The Soil Conservation Service, through the Watershed Protection Program, designs and constructs several hundreds of small floodwater retarding and multiple-purpose structures each year. A procedure has been developed for humid areas that provides the information concerning the sedimentation aspects required for the design of these structures. Involved in this procedure are quantitative estimates of erosion occurring in the drainage areas, the resultant sediment yields, the trap efficiency of the reservoir, and the volume weight and distribution of the deposited sediment within the reservoir. The success of the sediment design procedure is illustrated by comparisons of the computed requirements and the measured accumulation in selected reservoirs. (Knapp-USGS)
W70-05025

2K. Chemical Processes

CHEMISTRY OF MANGANESE IN NATURAL WATERS,
Soil Research Labs., Amritsar (India).
B. K. Handa.
Chemical Geology, Vol 5, No 3, p 161-165, January 1970. 5 p, 1 fig, 2 tab, 6 ref.

Descriptors: *Water chemistry, *Manganese, *Chemical precipitation, Calcium carbonate, Groundwater, Oxidation, Chemical reactions, Geochemistry, Trace elements.
Identifiers: Manganese complex ions.

In natural waters, manganese salts are much more stable than the corresponding iron salts. While the precipitation of iron was found to be complete within 48 hours from the time of collection of the water sample, generally only a small fraction of the total manganese had precipitated in about a week's time. However, once the precipitation starts, the process becomes relatively more rapid, perhaps due to autocatalysis. Even when precipitation of calcium carbonate occurs, some manganese may still remain in solution. (Knapp-USGS)
W70-04558

DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
Missouri Univ., Kansas City. Dept. of Chemistry.
For primary bibliographic entry see Field 07B.
W70-04561

TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962-SEPTEMBER 30, 1967,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Div. of Pollution Surveillance.
For primary bibliographic entry see Field 05A.
W70-04567

THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
Akademiya Nauk SSSR. Institut Okeanologii.
For primary bibliographic entry see Field 02L.
W70-04568

COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
Akademiya Nauk SSSR. Institut Okeanologii.
G. N. Baturin, A. V. Kochenov, and Ye. S. Trimonis.
Transl from Okeanologiya, Akad Nauk SSSR, Moscow, Vol 9, No 3. Oceanology, Vol 9, No 3, p 360-368, 1969. 9 p, 2 fig, 8 tab, 28 ref.

Descriptors: *Brines, *Saline water, *Iron oxides, *Bottom sediments, Oceanography, Water chemistry, Mineralogy, Water temperature, Chemical precipitation, Salts.
Identifiers: Red Sea, Iron deposits.

The hot brines in depressions of the central Red Sea contain thousands of times more iron, manganese and other nonferrous metals than the sea water. After removal of salts, approximately half of the sediments of these depressions consists of iron hydroxides and they are enriched with zinc, copper, lead and molybdenum. Hydrothermal deposits with the same complex of metals, located along the coast of the Red Sea, are correlated with faults and may be due to occurrences of Tertiary volcanism. Brines of similar composition to those in the Red Sea are known in the Cheleken Peninsula. Geological and geochemical data indicate that such brines are of relatively deep origin. (Knapp-USGS)
W70-04569

FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
S. I. Smirnov.
Transl from Okeanologiya, Akad Nauk SSSR, Moscow, Vol 9, No 3. Oceanology, Vol 9, No 3, p 355-360, 1969. 6 p, 3 fig, 9 ref.

Descriptors: *Brines, *Saline water, Sea water, Connate water, Salts, Salinity, Trace elements, Chlorides, Faults (Geology), Fractures (Geology), Water chemistry.
Identifiers: *Red Sea, Evaporite deposits.

The brines in the grabenlike bottom depressions of the Red Sea were formed by outflow of evaporite brines from Miocene salt-bearing deposits. This flow took place about 3500 years ago. In addition to high salinity (up to 310 g/liter), the brines have relatively high contents of potassium, iron, manganese, zinc, etc. Salt-bearing and gypsum-bearing Miocene rocks of thickness more than 2000-3000 m occur extensively in the Red Sea and adjoining land areas. (Knapp-USGS)
W70-04570

CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
Geological Survey, Salt Lake City, Utah.
A. H. Handy, R. W. Mower, and G. W. Sandberg.
Available for sale from Superintendent of Documents U S Government Printing Office, Washington, D C 20402-Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D228-D234, 1969. 7 p, 8 fig, 1 tab, 7 ref.

Descriptors: *Water quality, *Groundwater, *Utah, *Saline water, Monitoring, Artesian wells, Water chemistry, Withdrawal, Water levels, Water level fluctuations, Irrigation water, Leaching, Infiltration, Evaporation, Hydrogeology.
Identifiers: Great Basin (Utah).

The chemical quality of groundwater in three areas in the Great Basin, Utah, is known to be deteriorating. West of Kanosh in Pavant Valley, an increase in all major constituents except bicarbonate has been associated with a decline in water levels that has resulted from a high rate of pumping. In the upper artesian aquifer near Leamington, in the Sevier Desert, an increase in dissolved solids, mainly sodium and chloride, has resulted from a change in the chemical quality of the water that is recharging the aquifer. Between Beryl and Enterprise in Escalante Valley, an increase in the concentration of all major constituents also has been associated with a decline in water levels caused by a high rate of pumping. (Knapp-USGS)
W70-04579

THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
Harvard Univ., Cambridge, Mass. Dept. of Geological Sciences; University of Southern California, Los Angeles. Dept. of Geological Sciences; and Lamont-Doherty Geological Observatory, Palisades, N. Y.
Yuan-Hui Li, James Bischoff, and Guy Mathieu.
Earth and Planetary Science Letters, Vol 7, No 3, p 265-270, December 1969. 6 p, 1 fig, 1 tab, 26 ref. ONR Contract Nonr 266 (82); NSF Grants Ga-4239 and Ga-1419.

Descriptors: *Water chemistry, *Sea water, *Bottom sediments, *Arctic Ocean, *Manganese sampling, Cores, Analytical techniques, X-ray analysis, X-ray spectroscopy.
Identifiers: Arctic Basin.

A relatively high content of manganese at the top of an arctic sediment core and a smooth exponential increment of manganese concentration in its interstitial water down to one meter have been found. The data strongly support the idea that manganese may be remobilized after burial by local reducing conditions. The thermodynamic calculation shows that the interstitial water is reaching chemical equilibrium with respect to manganese carbonate precipitate in the deeper part of the sediment. (Knapp-USGS)
W70-04591

CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Cincinnati Water Research Lab.; and Cincinnati Univ., Ohio. Dept. of Mathematics.
D. L. Warner, and L. F. Doty.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 278-288, 1967. 11 p, 4 fig, 1 tab, 15 ref.

Descriptors: *Water chemistry, *Artificial recharge, Injection wells, Corrosion, Inhibition, Stabilization, Chemical precipitation, Water quality, Mixing, Chemical reactions, Physicochemical properties.
Identifiers: Injection well fouling, Water compatibility.

Chemical reaction between recharge water and aquifer water may influence water quality and aquifer permeability, and may cause fouling in discharge wells. However, evidence suggests that the danger of permeability reduction may not be very great. Precipitates of calcium and magnesium carbonate and iron compounds are the most likely reaction products. The amount and distribution of reactive chemicals remaining in solution can be related to the dispersive characteristics of a porous medium. Reactions of various rates are considered. It may be desirable to prevent reaction. It is suggested that, in some cases, this can be accomplished by emplacing a buffer zone of nonreactive water between the recharge water and the aquifer water. (Knapp-USGS)
W70-04615

THE NEBRASKA WATER QUALITY SURVEY,
Nebraska Univ., Lincoln. Coll. of Agriculture and Home Economics.
D. Knudsen, C. A. Hoover, P. Fischbach, and D. D. Axthelm.
Nebraska University Extension Service Report E. C. 65-165, November 1965. 26 p, 7 fig, 11 tab, 18 ref, append.

Descriptors: *Water quality, *Irrigation water, *Nebraska, *Groundwater, *Water pollution, Water chemistry, Water analysis, Data collections, Hydrologic data, Nitrates, Water pollution sources, Corrosion.
Identifiers: Groundwater pollution.

In general, the quality of Nebraska groundwater is good. There are, however, areas in the state where management practices should be followed to prevent excessive accumulation of salts. Potassium, calcium, magnesium and sulfur, all essential nutrient elements, are generally present in substantial quantities in Nebraska groundwater. Nearly two-thirds of the water samples tested contained enough boron to prevent boron deficiency in most crops. Thirty of the 1,166 samples tested furing the 1961 irrigation season had concentrations of 10 ppm or more nitrate-nitrogen. The 1,200 irrigation water samples of the year 1961 represent about 5% of the irrigation wells in the area of the state irrigated from groundwater. Laboratory determinations were made by the University of Nebraska Soil Testing Service for: Specific conductance, pH, Calcium, Sodium, Magnesium, Potassium, Nitrate, Phosphate, Carbonate, Bicarbonate, Chloride, Sulfate, Iron, and Boron. (Knapp-USGS)
W70-04616

SALT REJECTION BY SEA ICE DURING GROWTH,
Department of Energy, Mines and Resources, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 02C.
W70-04703

GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
Bureau of Mines, Bartlesville, Okla. Petroleum Research Center.
A. Gene Collins.

Bureau of Mines Report of Investigations 7326, January 1970. 31 p, 9 fig, 12 tab, 51 ref.

Descriptors: *Geochemistry, *Brines, *Oil fields, *Louisiana, Dolomite, Diagenesis, Connate water, Water chemistry, Geologic formations, Oil reservoirs, Saline water, Groundwater.
Identifiers: Oil field brines.

Some of the geochemical relationships between subsurface fluids and the geologic strata in petroleum-producing areas of Louisiana were determined. Samples of petroleum-associated water were obtained from 126 wells in Louisiana from sediments of Tertiary, Cretaceous, and Jurassic ages. The dissolved constituents were compared with those of a brine that was concentrated by evaporation. The concentrations of bromide, calcium, and strontium were useful in distinguishing the brines produced from sediments of a late age from those of an earlier age. The concentration ratios of Mg and bromide indicated that dolomitization probably had occurred and altered the composition of the brines. A principal-components analysis of the data indicated an inverse relationship between depth and concentrations of bromide, strontium, calcium, and lithium. (Knapp-USGS)
W70-04710

ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
Laboratory of Nuclear Geology, Pisa (Italy).
A. Longinelli, and G. Cortecci.
Earth and Planetary Science Letters, Vol 7, No 4, p 376-380, January 1970. 5 p, 4 fig, 1 tab, 9 ref.

Descriptors: *Stable isotopes, *Oxygen, *Sulfur, *Water chemistry, Solutes, Biochemistry, Water analysis, Aquatic microorganisms.
Identifiers: Isotope fractionation, Oxygen isotopes, Sulfur isotopes, Italy.

The isotopic composition of dissolved sulfate has been studied in the Arno and Serchio Rivers in Tuscany (Italy). Large isotopic variations in both oxygen and sulfur take place along the course of these rivers in the direction of a progressive enrichment in the heavy isotopes. It is difficult to explain the results obtained, which are probably caused by several different factors. One of these factors is probably a widespread microbiological activity. (Knapp-USGS)
W70-04715

CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,
Geological Survey, Portland, Oreg.
D. A. Curtiss.
Geological Survey Open-file report, 1969. 25 p, 4 fig, 6 tab, 8 ref.

Descriptors: *Water quality, *Surface waters, *Oxygen, Water chemistry, Solutes, Nutrients, Pesticides, Monitoring, Water pollution sources, Water supply, Data collections, Hydrologic data.
Identifiers: Umpqua River (Oregon), Douglas County (Oregon).

Samples were collected at 32 sites in the Umpqua River basin, Oregon; six of these sites were sampled and analyzed at 6-week intervals. The surface water is of generally excellent chemical quality throughout the basin. Analysis of water samples from two selected sites revealed detectable amounts of pesticides during the summer and fall of 1967. Herbicides were not detected during the study period. All surface water within the basin has a low sodium hazard and only traces of boron, and is therefore excellent for irrigation. A potential problem area exists on the South Umpqua River downstream from Roseburg. Because of heavy organic enrichment, insufficient discharge during low-flow periods and high temperatures during summer could cause water-quality problems. The water quality in this reach of the river should be monitored on a regular basis. (Knapp-USGS)
W70-04722

A ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM BY ELECTROLYTIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING,
Ministry of Technology, London (England). Lab. of the Government Chemist.
P. Metson.
Analyst, Vol 94, No 1125, p 1122-1129, December 1969. 8 p, 4 fig, 2 tab, 17 ref.

Descriptors: *Tritium, *Water analysis, Analytical techniques, Radiochemical analysis, Radioisotopes, Electrolysis.
Identifiers: Tritium analysis.

A routine method is described for the measurement of tritium in rain and river waters by liquid scintillation counting after enrichment by electrolysis. A relatively large enrichment is achieved in a small cell by use of a continuous feed system that requires a minimum of attention. Electrolysis is carried out in a bank of standardized cells, and activities are obtained to an accuracy of better than 15% without the need for deuterium determinations. (Knapp-USGS)
W70-04735

IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
Army Terrestrial Sciences Center, Hanover, N.H.
Jerry Brown.
Cold Regions Research and Engineering Laboratory Research Report 272, October 1969. 25 p, 3 fig, 16 ref, 1 append. DA Task 1T061102B52A02.

Descriptors: *Permafrost, *Soil chemistry, *Water chemistry, *Solutes, Ions, Aqueous solutions, Leaching, Geomorphology, Freezing, Melting, Ion transport, Tundra, Soil water movement, Sea water.
Identifiers: Ionic concentration gradients.

The ionic concentration gradients of soils and permafrost sediments were investigated to provide a means of interpreting present and past chemical activity and geomorphological processes in the Arctic coastal plain environment. Within short distances at comparably shallow depths and in sediments of similar texture, ionic concentrations commonly vary between less than 1 meq/100 g and 10 meq/100 g. These differences represent modification of the marine sediment by such processes as lake migration and freshening, local and regional thawing, and leaching followed by refreezing of the ground. Higher concentrations (more than 5 meq/100 g) are found close to the surface in areas unaffected by such processes. Lower values (less than 5 meq/100 g) are encountered in present and ancient lake basins and under several apparent primary land surfaces. Two areas, one a drained lake basin and the other a well-developed polygon field, show depression of the ionic concentrations both vertically and laterally. A large drained basin situated close to sea level contains frozen sediments having very low ionic concentrations; this suggests the prior existence of a fresh-water lake. The seasonally thawed soil contains, on an average, 24 times fewer extractable ions than the underlying permafrost. Data for all samples are tabulated and include moisture content, conductivity of solution, and concentrations in solution and soils. (Knapp-USGS)
W70-04736

CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
Koninklijke Nederlandse Akademie van Wetenschappen, Amsterdam.
H. L. Golterman, and R. S. Clymo.
Proceedings of International Biological Program Symposium held in Amsterdam and Nieuwersluis, Netherlands, October 10-16, 1966. N V Noord-Hollandsche Uitgevers Maatschappij, Amsterdam, 1967. 322 p.

Descriptors: *Aquatic habitats, *Chemical analysis, *Aquatic environment, *Conferences, Environmental effects, Productivity, Physiological ecology, Organic matter, Bioassays, Nutrients, Phosphorus compounds, Nitrogen compounds, Nitrogen fixation, Oxidation reduction potential, Hydrogen ion concentration, Oxygen, Iron, Salinity, Vitamins, Sea water, Estuaries, Lakes, Plant pigments, Sediment-water interfaces, Molybdenum, Algae.
Identifiers: *Chemical environment, Hydrochemistry, International Biological Program, Netherlands, Netherlands Organization for Pure Scientific Research, Amsterdam (Holland), Nieuwersluis (Holland), Royal Netherlands Academy of Sciences, Hydrobiological Institute (Netherlands), Silicon compounds, Humic substances, Micronutrients, Microcompounds, Nutrient availability, Glucose, Acetate, Pheromones.

In October 1966, a symposium met at Royal Netherlands Academy of Sciences (Amsterdam) and Hydrobiological Institute (Nieuwersluis) to consider biologically-related problems of hydrochemistry. The conference, which this volume records, was sponsored by International Biological Program and Netherlands Organization for Pure Scientific Research. With an objective of preparing a manual of standardized methods, participants considered four types of problems: fate and determination of organic substances; availability of specific nutrient elements; physico chemical phenomena including nitrogen fixation, pH regulation, and interactions at sediment-water interfaces; and analytical techniques. Published proceedings are organized into 6 chapters as follows (numbers of contributions to each chapter indicated in parentheses): general papers (3); silicon, nitrogen, phosphorus compounds (5); technical papers (9); humic acids (2); micronutrients, microcompounds, and availability of compounds (6); miscellaneous topics (5). Topical coverage of some selected papers will indicate flavor, scope, and coverage of the symposium: 'integrative' and 'specific' properties of aquatic environments; quantitative relationships between nitrogen and phosphorus compounds in water and seston; automation in water analysis; composition and behavior of yellow acids in lacustrine water; determination of vitamins in seawater; pheromones and related substances; control of cations and pH in Sphagnum communities; mobility of sedimental compounds as related to sediment-water interchange. (See also W70-04882 and W70-04823). (Eichhorn-Wisconsin)
W70-04821

AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
Wisconsin Univ., Madison. Water Chemistry Lab.
For primary bibliographic entry see Field 07B.
W70-04822

DETERMINATION OF VITAMINS IN SEAWATER,
California Univ., San Diego, La Jolla. Inst. of Marine Resources.
For primary bibliographic entry see Field 07B.
W70-04823

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
Washington Univ., Seattle. Dept. of Oceanography.
For primary bibliographic entry see Field 02L.
W70-04996

SALINITY MEASUREMENTS IN ESTUARIES,
Swarthmore Coll., Pa. Dept. of Physics, and Woods Hole Oceanographic Institution, Mass.
For primary bibliographic entry see Field 02L.
W70-04999

CIRCULATION AND DIFFUSION,
Liverpool Univ. (England). Dept. of Oceanography.
For primary bibliographic entry see Field 02L.
W70-05004

DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
Yale Univ., New Haven, Conn. Dept. of Geology.
Robert A. Berner.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 268-272, 1967. 5 p, 4 fig, 18 ref.

Descriptors: *Diagenesis, *Sulfides, *Sediments, Pyrite, Iron, Sulfur, Hydrogen sulfide, Thermodynamics, Oxidation-reduction potential, Acidity, Water chemistry.
Identifiers: *Hydrotroilite, Limonite, Goethite, Marcasite.

Hydrotroilite, a fine-grained, black, iron sulfide is frequently found in recent sediments. X-ray and chemical study of hydrotroilite is difficult because of its low concentration, extreme susceptibility to air oxidation and fine-grained nature. Laboratory studies of iron components used metallic iron, dissolved ferrous iron and synthetic and natural goethite. The Eh of sediments containing hydrogen sulfide is discussed. The stability of iron minerals in anaerobic marine sediments is best expressed in terms of Eh-pS (-2) diagrams calculated from thermodynamic data. The mechanisms of transformation of FeS to pyrite are discussed. (Carstea-USGS)
W70-05008

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
Washington Univ., Seattle. Dept. of Oceanography.
For primary bibliographic entry see Field 02L.
W70-05017

2L. Estuaries

THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
Akademiya Nauk SSSR. Institut Okeanologii.
Yu. D. Shuyskiy.
Transl from Okeanologiya, Akad Nauk SSSR, Vol 9, No 3. Oceanology, Vol 9, No 3, p 388-391, 1969. 4 p, 3 fig, 6 ref.

Descriptors: *Beach erosion, *Sediment transport, *Storms, Ocean waves, Geomorphology, Littoral drift, Surf, Damages, Erosion.
Identifiers: Baltic Sea.

The Baltic suffered a very violent recurring storm during October 17-20, 1967. It washed away the dunes over the entire stretch of the coast from the Samland Peninsula to the Gulf of Riga. The extent of erosion was 8000-24,000 cu m/km in 15-16 h. Different types of erosion are observed in different parts of the coast. However, the profile of the submarine slope remained relatively stable to a depth of 7-8 m. The position of the water's edge did not change, with the exception of sectors with steep submarine slopes. (Knapp-USGS)
W70-04566

THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
Akademiya Nauk SSSR. Institut Okeanologii.
V. V. Serova.
Transl from Okeanologiya, Akad Nauk SSSR, Moscow, Vol 9, No 3. Oceanology, Vol 9, No 3, p 378-388, 1969. 11 p, 5 fig, 1 tab, 17 ref.

Descriptors: *Sediments, *Indian Ocean, *Mineralogy, *Provenance, Chemical analysis, Suspended load, Sampling, Particle size, Silts, Antarctic.
Identifiers: Granulometric analysis.

Study of the mineralogical composition of centrifuged samples of suspended matter in the Indian Ocean revealed long-distance scattering of silt-sized particles. Terrigenous minerals are traced in the southern part of this ocean for a distance of more than 2000 km from their Antarctic sources. A similar picture is observed in the northern parts (Bay of Bengal, Arabian Sea). (Knapp-USGS)
W70-04568

COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
Akademiya Nauk SSSR. Institut Okeanologii.
For primary bibliographic entry see Field 02K.
W70-04569

THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
Harvard Univ., Cambridge, Mass. Dept. of Geological Sciences; University of Southern California, Los Angeles. Dept. of Geological Sciences; and Lamont-Doherty Geological Observatory, Palisades, N. Y.
For primary bibliographic entry see Field 02K.
W70-04591

VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
System Development Corp., Santa Monica, Calif.
For primary bibliographic entry see Field 7C.
W70-04600

EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
Geological Survey, Miami, Fla. Water Resources Div.
For primary bibliographic entry see Field 02F.
W70-04606

A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
Alberta Univ., Edmonton; and Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 04B.
W70-04610

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
Windsor Univ. (Ontario). Dept. of Civil Engineering and Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 04B.
W70-04612

SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
S. Schmorak.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 305-318, 1967. 14 p, 9 fig, 4 ref.

Descriptors: *Saline water intrusion, *Saline water-freshwater interfaces, Observation wells, Monitoring, Logging (Recording), Groundwater movement, Arid lands, Electrical well logging, Water levels, Recharge, Discharge (Water), Aquifers.
Identifiers: *Israel.

Field investigations have been carried out by the Hydrological Service since 1954 in three rows of specially constructed interface wells in the Plio-Pleistocene aquifer along the Mediterranean Coast of Israel. The purpose of the investigations was to find the exact location of the interface, to follow up its movement and to ascertain the velocity of the propagation inland in order to enable a rational exploitation of the aquifer. Methods of chemical logging have been developed and instruments built for measuring of electrical conductivity and temperature in situ and for recording of the interface movement. The tidal movement of the water level and the corresponding movement of the interface is being automatically recorded. The velocity of salt water encroachment was found to be approximately 20-70 m per year. The horizontal boundary of the salt water (toe of interface) has been found to be 0.2-1.6 km from the sea (except in the Tel-Aviv Region where distance is more than 2 km). (Knapp-USGS)
W70-04613

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
Texas A and M Univ., College Station. Water Resources Inst.
R. J. Baldauf, J. Von Conner, H. W. Holcombe, and F. M. Truesdale.
Available from the Clearinghouse as PB-190 269, $3.00 in paper copy, $0.65 in microfiche. Technical Report No 26, Texas Water Resources Institute, February 1970. 168 p, 27 tab, 22 fig, 101 ref. OWRR Project A-007-TEX.

Descriptors: *Estuaries, Ecology, Environmental effects, *Acquatic environment, Estaurine environment, Estaurine fisheries, *Crabs, *Shrimp.
Identifiers: Water development effects, Blue crab, White shrimp, Brown shrimp, *Menhaden (Gulf), Trinity Bay, Wallisville Reservoir (Proposed).

The study was done on the site of the proposed Wallisville Reservoir, one of several multipurpose structures designed for the water development of the Trinity River Basin in Texas. The Dam is to be located at Trinity River mile 3.9, where it will traverse about 22,000 acres of a low salinity marsh. The completion of the Wallisville Dam is expected to alter both the character of the marsh and of the Trinity Bay portion of the Galveston Bay System. The Dam will serve as an effective saltwater barrier in addition to serving as a river-water impoundment structure; about 12,500 acres of low salinity marsh will be inundated by the conservation pool. The study shows that the entire area serves as a nursery ground for white and brown shrimp, blue crab, and menhaden, and that this area will be lost to the dam site. The construction of the dam at least 4.5 miles farther upstream would have spared considerable nursery acreage from destruction.
W70-04687

TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
J. R. Schubel.
Chesapeake Bay Institute Technical Report 63, Reference 70-2, Johns Hopkins University, February 1970. 28 p, 8 fig, 5 tab, 4 ref.

Descriptors: *Sediment load, *Sedimentation, *Suspended load, *Estuaries, Particle size, Velocity, Currents (Water), Tides, Deposition (Sediments), Erosion, Scour, Sediment transport, Bays, Sampling, Surveys, Data collections.
Identifiers: Chesapeake Bay.

Sediment size analyses were made of suspended sediment samples collected over a tidal cycle in Chesapeake Bay at three depths in 9.5 m of water. At the surface the volume-weighted mean Stokes' diameter ranged from 2.9 to 3.7 microns while the concentration of suspended sediment varied from 11.2 to 14.6 mg/liter. At 8 m the mean Stokes' diameter, the standard deviation, and the concentration of suspended sediment were progressively larger with increasing current speed and had their slack water background values with waning tidal currents. The mean Stokes' diameter ranged from 2.9 to 11.7 microns, the standard deviation from 5.2 to 14.5 microns, and the concentration of suspended sediment from 13.8 to 93.0 mg/liter. At 9 m the same pattern was observed, but the variations were greater. The mean Stokes' diameter ranged from 3.3 microns near slack water to 22.9 microns at maximum current. The standard deviation ranged from 5.0 to 24.5 microns and the concentration of suspended sediment from 19.5 to 201.1 mg/liter. (Knapp-USGS)
W70-04696

OCEANIC MIXING,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
Akira Okubo.
Chesapeake Bay Institute, Technical Report 62, Reference 70-1, Johns Hopkins University, January 1970. 119 p, 17 fig, 160 ref. Contract AT (30-1)-3109, USAEC Contract Nonr 4010 (11) ONR.

Descriptors: *Mixing, *Oceans, *Ocean currents, *Reviews, *Bibliographies, Diffusion, Turbulence, Advection, Convection, Environment, Path of pollutants, Mathematical models, Model studies.
Identifiers: Oceanic mixing.

The present knowledge of oceanic mixing is summarized. Two processes, 'advection' and 'diffusion,' which contribute substantially to oceanic mixing and their interaction are recognized in the mechanism of mixing. Environmental features of the sea in relation to advective and diffusive processes are also described. An annotated bibliography is included. (Knapp-USGS)
W70-04697

A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
Naval Undersea Research and Development Center, San Diego, Calif.
J. L. Cairns, and K. W. Nelson.
Journal of Geophysical Research, Vol 75, No 6, p 1127-1131, February 20, 1970. 5 p, 5 fig, 8 ref.

Descriptors: *Water temperature, *Sea water, *Thermocline, *Thermal stratification, *Coasts, California, Pacific Ocean, Ocean currents.
Identifiers: San Diego (Calif).

Details of the annual thermocline cycle in the coastal area off San Diego have been determined from temperature data recorded hourly for over a year at the Naval Undersea Research and Development Center Oceanographic Tower. Vertical thermal gradients averaged 0.59 deg C/m at their strongest part from late April through early September. The sharpest gradients, which occurred in late June, were as great as 1.27 deg C/m. Transient gradients averaging 0.29 deg C/m at their strongest part occurred frequently in late March and early April and from late September through early November. Weak thermal gradients averaging 0.15 deg C/m at their sharpest predominated from late November through early March. Water temperature varied from 9.7 deg to 23.6 deg C. Internal tides persisted throughout the year, contributing to monthly temperature variances that ranged from 0.2 in January to 5.6 in May and August. (Knapp-USGS)
W70-04706

A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
Hokkaido Regional Fisheries (Japan). Research Lab.
Kiyomitsu Kitano.
Journal of Geophysical Research, Vol 75, No 6, p 1110-1115, February 20, 1970. 6 p, 5 fig, 13 ref.

Descriptors: *Thermal stratification, *Ocean circulation, *Ocean currents, Oceanography, Water temperature, Mixing.
Identifiers: *Bering Sea, Aleutian Islands.

A detailed thermal structure in the eastern Bering Sea is described, based on data obtained during the summers of 1964-66. Extremely cold water moves over the continental shelf in the eastern Bering Sea and warm water intrudes mainly across the Amukta and Amchitka passes. Some of the tendency of decrease and increase of temperature is also shown by a vertical section. The typical feature of vertical temperature distribution is the presence of five stratified thermal layers. (Knapp-USGS)
W70-04708

AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
Oregon State Univ., Corvallis. Dept. of Oceanography.
Hasong Pak, George F. Beardsley, Jr., and Robert L. Smith.
Journal of Geophysical Research, Vol 75, No 3, p 629-636, January 20, 1970. 8 p, 8 fig, 12 ref. ONR Contract Nonr 1286 (10).

Descriptors: *Ocean circulation, *Water temperature, *Productivity, Oregon, Oceanography, Ocean currents, Thermal stratification, Hydrography, Sounding, Surveys.
Identifiers: Ocean upwelling.

Optical and hydrographic measurements made in June 1967 during upwelling along the Oregon coast showed a temperature inversion starting 3 km from the shore and extending to 13 km from the shore. The thermal inversion was accompanied by a turbidity maximum in the permanent pycnocline. The mechanism for the formation of the temperature inversion and turbidity maximum appears to be cold, saline water upwelling from beneath the permanent pycnocline to the surface close to the coast, absorbing heat, and becoming biologically productive. This modified upwelled water then appears to move gradually offshore, sinking along the permanent pycnocline which slopes up to near the surface during upwelling. The modified upwelled water is warmer (but more saline), contains more scatterers than water of similar densities offshore, and thus appears as a thermal and optical inversion. The turbidity maximum was observed to persist after the temperature inversion disappeared, which would indicate that the circulation pattern remains even when insufficient heat is absorbed by the upwelled water to generate a thermal inversion. (Knapp-USGS)
W70-04709

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
For primary bibliographic entry see Field 05B.
W70-04716

PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
Woods Hole Oceanographic Institution, Mass.
Bostwick H. Ketchum.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 329-335, 1967. 7 p, 10 fig, 1 tab, 12 ref. Contracts AT (30-1)-1918 (AEC), and No 2196 (ONR).

Descriptors: *Nutrients, *Estuaries, *Eutrophication, Phosphorus, Water pollution, Salinity, Rivers, Phytoplankton, Sea water, Brackish water, Mixing.
Identifiers: Juan de Fuca Strait, New York Bight.

Estuaries can be enriched in nutrients by river waters, pollution, or sea water. Local enrichment of estuaries by rivers may be important, but it appears that this source cannot usually be invoked to explain productivity. The Strait of Juan de Fuca is cited as an example of nutrient enrichment due to sea water drawn from depths below the euphotic zone. In this zone, the concentration of nutrients has not been depleted by the growth of phytoplankton. Total phosphorus and salinity were used to identify 3 different sources of water in the New York Bight. The 3 types of water are: (1) Brackish river water with 30 ppt salinity; (2) surface coastal water with 30.95 ppt and (3) deep ocean water with 34 ppt salinity. In addition to the type of water, the population of phytoplankton will depend on factors such as grazing, the stability of the water column, the presence of vitamins or inhibitors in the water, and water transparency. (Carstea-USGS)
W70-04993

LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
Research Inst. for Geology and Biology. Wilhelmshaven (West Germany).
For primary bibliographic entry see Field 02J.
W70-04994

ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
Copenhagen Univ. (Denmark). Geographical Lab.
Axel Schow.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 129-145, 1967. 17 p, 23 fig, 33 ref.

Descriptors: *Estuaries, *Research and development, Tidal effects, Glaciation, Channels, Sediments, Sedimentation rates, Salt marshes, Land reclamation.
Identifiers: *Denmark, *Jutland Peninsula, Danish Moraine Archipelogo.

Tidal environment in Denmark is discussed,including the glacio-geomorphological characteristics, marine activity, tidal flats and tidal channels of the Danish Archipelago. Results of research programs in erosional forms (tidal creeks and tidal channels), rate of sedimentation, and accumulation forms (tidal flats and salt marshes) are discussed. Estuarine research is used as a basis for land reclamation and study of the paleogeography of the Danish estuary region. Denmark is an archipelago in the strictest sense and its land is strongly dissected by water. Typical estuarine conditions occur only on the southwest shoreline of the Jutland Peninsula. (Carstea-USGS)
W70-04995

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
Washington Univ., Seattle. Dept. of Oceanography.
M. Grant Gross.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 273-282, 1967. 10 p, 10 fig, 3 tab, 36 ref.

Descriptors: *Trace elements, *Sediments, *Sedimentation, *Fjords, Inlets (Waterways), Diatoms, Sulfides, Sea water, Sediment-water interfaces, Elements (Chemical).
Identifiers: *Canada, *Saanich Inlet, *British Columbia, Stagnant Fjords.

The concentration of a minor element in sediments of Saanich Inlets, British Columbia, depends on the concentration of the elements in the lithogenous and biogenous sources of bottom sediments and in the sulfide-bearing water. Sc, Y, Ti, Zr, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, and Pb were associated primarily with the lithogenous constituents. The concentration of Mo increases in deposited sediments and is probably coprecipitated with iron sulfides from sea water near the water-sediment interface. The concentrations of other minor elements in the sediments did not change greatly. (Carstea-USGS)
W70-04996

SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
Washington Univ., Seattle. Dept. of Oceanography.
Maurice Rattray, Jr.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 52-62, 1967. 11 p, 21 fig, 11 ref.

Descriptors: *Water circulation, *Fjords, Salt balance, Pressure, Bathymetry, Estuaries, Equations, Diffusion, Advection.
Identifiers: *Strait of Georgia, *Strait of Juan de Fuca, San Juan Channels.

Dynamic balance and salt balance were used to describe water circulation in fjords. In most cases, the balance of forces is given by the equality of the

horizontal pressure gradient and the vertical gradient of turbulent stress. The exceptions occur when the horizontal acceleration terms become important in the upper circulation, or because of bathymetric effects. Upper circulation is the unique feature of fjords which separates them dynamically from other estuarine systems. The salt-balance equation represents a balance between horizontal advection and diffusion over the sills; a balance between vertical diffusion, and possible time changes in the deep circulation; and between advection and vertical diffusion in the near-surface circulation. Examples are given to illustrate the dynamic balance which exists for a wide range of fjord conditions. An approximate similarity solution, given for the circulation in the upper layers of a fjord, provides a good representation of all the important features of this circulation. (Carstea-USGS)
W70-04997

THE ONTOGENY OF A SALT MARSH ESTUARY,
Woods Hole Oceanographic Institution, Mass.
Alfred C. Redfield.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 108-114, 1967. 7 p, 6 fig, 1 tab, 13 ref. NSF Contract GP 2042.

Descriptors: *Estuaries, *Salt marshes, *Sedimentation, Sediments, Radioactive dating, Carbon radioisotopes, Dating, High water mark, Sea level, Sedimentary structures, Channels, Meanders.
Identifiers: *Salt marsh estuary, Sand spits.

The history of the development of a typical New England salt marsh (Sandy Neck, Mass), and of the estuary which it now occupies is reconstructed. The depth of peat decreases progressively eastward along the south side of Sandy Neck. Relief similar to that of the adjacent upland is suggested by the contours along the upland margin of the marsh, whereas the relief is relatively low in the central part. A series of cores was collected across the marsh from the upland to one of the major creeks to examine the relation of high marsh peat, intertidal peat, and composition of the substratum. Carbon-14 dating was used to establish the time at which mean high water reached any given elevation as sea level rose. The sand spit has grown eastward during a period of about 4,000 years. The development of marsh along the margin of the sand spit proceeded more slowly because the basin deepened with distance from the upland and more time was required for sedimentation to reduce its depth. High marsh has now extended to the margin of meandering channels and the creeks now are in quasi-equilibrium with the hydraulic forces. (Carstea-USGS)
W70-04998

SALINITY MEASUREMENTS IN ESTUARIES,
Swarthmore Coll., Pa. Dept. of Physics, and Woods Hole Oceanographic Institution, Mass.
Paul C. Mangelsdorf, Jr.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 71-79, 1967. 9 p, 6 fig, 24 ref.

Descriptors: *Salinity, *Estuaries, Mixing, Tracers, Ecology, Instrumentation, Electrical conductance, Analytical techniques, Specific gravity, Electrodes, Membranes, Ion exchange.
Identifiers: Estuarine salinity determinations.

Salinity measurements in estuaries can be used for: (1) Studies of transport, flushing and mixing; (2) a tracer to label different water masses; (3) ecological factors, and (4) water uses for the streams flowing into an estuary. Salinity can be measured by determination of the electrical conductivity of water. Conductivity meters, chlorinity titrations, specific gravity methods, refractive index, selective electrodes, sodium electrode, and ion-exchange membrane electrodes are used to determine salinity. (Carstea-USGS)
W70-04999

EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.
James P. Morgan.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 115-120, 1967. 6 p, 8 fig, 19 ref.

Descriptors: *Estuaries, *Deltas, *Quaternary period, Rivers, Land subsidence, Channels, Sea level, Sedimentation, Ocean waves, Tidal energy, Tidal waters, Coasts.
Identifiers: Mississippi Delta, Ganges-Brahmaputra, Deltaic estuaries, Interdeltaic estuaries, Estuarine tidal channels.

The Quaternary history of river mouths is discussed. The physiography of a deltaic area is the product of fluvial deposition and coastal erosion as influenced by the predeltaic topography. Three distinct deltaic estuarine types are, deltaic estuaries, interdeltaic estuaries, and estuarine tidal channels. Illustrations were selected from the Mississippi Delta (a low-tide and low-energy environment) and the high-tide regime of the Ganges-Brahmaputra system. Deltaic estuaries are a product of the delicate balance between variations in sea level, coastal progradation through sedimentation, and coastal retreat under wave attack. Estuarine morphology of the deltaic environment is subject to rapid modification and, from the standpoint of geologic time, deltaic estuaries are ephemeral in nature. (Carstea-USGS)
W70-05000

REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
Australian National Univ. (Canberra).
J. N. Jennings, and E. C. F. Bird.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 121-128, 1967. 8 p, 10 fig, 33 ref.

Descriptors: Estuaries, *Geomorphology, *Sedimentation, River flow, Tides, Sediments, Mineralogy, Sands, Beach erosion, Dunes, Sedimentary structures, Runoff, Bays, Barriers.
Identifiers: Australia, Estuarine geomorphology.

The estuarine geomorphology of Australia is discussed in terms of: (1) river flow; (2) wave energy; (3) tides; (4) sedimentation processes; (5) mineralogy of beach sands and lithology of dunes; and (6) neotectonic effects. Due to aridity, the Australian rivers generally have low runoff coefficients and only few have perennial flow. Extensive barriers have been built up at the river mouths along the coast of Australia from Shark Bay in Western Australia southward to Cape Leeuwin, eastward to Cape Howe, and northward to Fraser Island in Queensland. This coast is characterized by a high wave energy. The tropical coasts are subject to less persistently energetic wave regimes. The high wave energy coasts have low to moderate tidal ranges whereas the tropical coasts are subject to tides of moderate or high ranges. Sedimentation is influenced by biotic factors of salt marshes, mangrove swamps, and reed swamps. (Carstea-USGS)
W70-05001

SEDIMENTS OF YAQUINA BAY, OREGON,
Oregon State Univ., Corvallis. Dept. of Oceanography.
For primary bibliographic entry see Field 02J.
W70-05002

SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
Bergen Univ. (Norway). Inst. of Geography.
Odd H. Saelen.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 63-70, 1967. 8 p, 14 fig, 3 ref.

Descriptors: *Fjords, *Hydrography, Glaciation, Salinity, Stratification, Density, Water circulation, Currents (Water), Fresh water, Brackish water.
Identifiers: *Norwegian fjords, Sognefjord, Hardangerfjord.

The length of Norwegian fjords varies from a few kilometers up to the 176 km of Sognefjord. Aside from being the largest, this fjord is also the deepest with a maximum depth of nearly 1,300 m. Most of the Norwegian fjords do not exceed 600 m. Most fjords have 2 water layers. The upper layer has low salinity and density; the lower layer has high salinity and density. This stratification varies seasonally and it is most pronounced during summer. The two main features of fjord circulation are currents connected with fresh water supply and movements in the deeper layer. (Carstea-USGS)
W70-05003

CIRCULATION AND DIFFUSION,
Liverpool Univ. (England). Dept. of Oceanography.
K. F. Bowden.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 15-36, 1967. 22 p, 10 fig, 3 tab, 68 ref.

Descriptors: *Water circulation, *Diffusion, *Estuaries, Saline water intrusion, Mixing, River flow, Flow, Coriolis force, Model studies, Diffusivity, Salinity, Fjords.
Identifiers: *Estuarine circulation.

Estuarine circulation types include salt wedge, two-layer flow with entrainment, two-layer flow with vertical mixing, vertically homogeneous (with lateral variation and laterally homogeneous), and intensive mixing. Interaction between the river flow and tidal currents is influenced by the physical dimensions of the estuary and by the Coriolis force. The basic principles of circulation and mixing are briefly summarized. Flushing time, two-layer models, tidal prism and segmentation methods, mixing length theory, effective horizontal diffusivity, and other methods have been devised for computing the rate at which river water is flushed out of an estuary. Diffusion problems and wind effects on estuarine circulation are discussed. Water movements, mixing processes, and the distribution of salinity which results from their combined action are the main physical problems to be investigated in an estuary. (Carstea-USGS)
W70-05004

THE SEDIMENTS OF CHESAPEAKE BAY,
Maryland Univ., Solomons. Natural Resources Inst.
For primary bibliographic entry see Field 02J.
W70-05005

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
Public Health Service, Cincinatti, Ohio. Div. of Water Supply and Pollution Control.
For primary bibliographic entry see Field 05B.
W70-05006

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
University of Southern California, Los Angeles. Dept. of Geological Sciences.
For primary bibliographic entry see Field 02J.
W70-05007

DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
Yale Univ., New Haven, Conn. Dept. of Geology.
For primary bibliographic entry see Field 02K.
W70-05008

SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
Virginia Inst. of Marine Science, Gloucester Point; and Virginia Univ., Charlottesville. Dept. of Geology.
M. M. Nichols, and R. L. Ellison.
NSF Grant G20443. In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 283-288, 1967. 6 p, 6 fig, 2 tab, 10 ref.

Descriptors: *Estuaries, *Sediments, *Sedimentation, *Aquatic microorganisms, Microorganisms, Coastal plains, Marshes, Aquatic life, Rivers, Fresh water, Shoals, Sedimentation rates, Brackish water.
Identifiers: *Rappahannock Estuary, Foraminifera, Ostracoda.

Core samples were taken of surface sediments from 148 stations in waters and marshes of the Rappahannock Estuary in northeastern Virginia. The sedimentary Foraminifera, Ostracoda, and Thecamoebina were studied. Different types of estuarine waters appear to determine the patterns of microfauna. The river subfacies containing Thecamoebina are found in the freshened part of the estuary; arenaceous Foraminifera are found in the shoal subfacies; the lower, deeper water of the estuary is inhabited by the basin subfacies of calcareous Foraminifera. Standing crops of Foraminifera may change in size and position from year to year. The ratios of living specimens of Foraminifera to total tests showed little relationship to the sedimentation rates. Comparison with other areas is discussed. (Carstea-USGS)
W70-05009

COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
Pennsylvania Univ., Philadelphia. Dept. of Geology.
For primary bibliographic entry see Field 02J.
W70-05010

QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
Florida Univ., Gainesville. Coastal Engineering Lab.
J. A. Battjes.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, - 185-190, 1967. 6 p, 3 fig, 1 tab, 5 ref.

Descriptors: *Littoral drift, *Sediment transport, Research and development, Inlets (Waterways), Sands, Tracers, Tracking techniques, Aerial photography, Ocean waves, Currents (Water).
Identifiers: Coastal sedimentation.

Longshore sand drift, sand transport through inlets and stability of inlets are discussed quantitatively. Littoral drift is measured in the field and laboratory by fluorescent tracer and aerial photography methods. Aerial photography of several wave lengths of the migrating sand waves gives simultaneous quantitative data over an extended area and shows patterns and details. The laboratory equipments are carried out in tanks and the effects of both waves and currents on sediment transport are studied. The three kinds of inlet stability are bypassing stability, location stability and cross-sectional stability. (Carstea-USGS)
W70-05011

RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
Miami Univ., Fla. Inst. of Marine Science.
Gene A. Rusnak.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 180-184, 1967. 5 p, 5 fig, 20 ref.

Descriptors: *Sedimentation rates, *Sediments, *Estuaries, Deposition (Sediments), Environment, Continental shelf, Continental slope, Deep water, Rivers, Provenance, Lagoons, Bays, Climates, Arid climates, Humid climates.
Identifiers: Estuarine sedimentation.

The four broad environmental categories of marine sedimentation are: (1) The marginal marine environment containing estuaries; (2) the continental shelf; (3) the continental slope; and (4) the deep sea. Positive-filled estuaries are those that are filled entirely by river-transported sediment inflow. Inverse-filled estuaries are those that are filled solely or to the largest extent by sediments entering the estuary from the sea. Redistribution of basin sediment from local shoreline margins within the basin can be considered as neutral-filled (non-filling) basins. The rate of sediment accumulation in a basin is dependent upon source of supply, geographic position, and climate. The best estimates for accumulation rates are 2 m per thousand years for humid bays and estuaries, and 1 m per thousand years for arid and semi-arid lagoons. (Carstea-USGS)
W70-05012

ORIGIN OF SEDIMENTS IN ESTUARIES,
Paris Univ. (France). Institut de Geographie.
Andre Guilcher.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 149-157, 1967. 9 p, 12 fig, 37 ref.

Descriptors: *Sediments, *Provenance, *Estuaries, Sediment discharge, Suspended load, Deltas, Rivers, Slopes, Deposition (Sediments), Sediment transport, River beds, Tidal waters.
Identifiers: Estuarine sedimentation.

A possible source of estuarine sedimentation differences may be the quantitative contrasts in discharge of solid materials by rivers. Fine material eroded from the slopes of estuaries can take the place of sediments coming from upstream when river discharge is insignificant. Water motion within the estuary must also be taken into account. The penetration of marine sediments into estuaries can be due to the wedge of salt water flowing upstream along the bottom. In some estuaries, a motionless lens of water persists near the bottom during a large part of the tidal period. The position and duration of this motionless water body varies with the river discharge and tidal range. The lens acts as a weir in which the coarse particles flowing along the bottom are trapped, whereas the finer elements flowing in suspension in the upper water layer pass over it. If the lens is located near the mouth of the river, a delta can be built; but if it is located far upstream, the fluvial sediments settle before they reach the middle and lower parts of the estuary. (Carstea-USGS)
W70-05013

WHAT IS AN ESTUARY: PHYSICAL VIEW POINT,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
Donald W. Pritchard.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 3-5, 1967. 3 p.

Descriptors: *Estuaries, *Classification, *Tidal waters, Salinity, Mixing, Water circulation, Bays, Fjords, Rivers, Valleys, Water chemistry, Barriers, Sedimentary structures, Density.
Identifiers: Definition of estuaries, Classification of estuaries.

A definition of an estuary should recognize certain basic similarities in the distribution of salinity and density. The circulation pattern, mixing processes and the importance of boundaries which control the distribution of physicochemical properties in an estuary should also be considered. A definition is given which takes into account these considerations. This definition is widely recognized. Based on geomorphological considerations, estuaries are classified into 4 primary groups: (1) drowned river valley; (2) fjord-type estuaries; (3) bar-built estuaries; and (4) estuaries produced by tectonic processes. Each one of these categories is briefly discussed and examples are provided. (Carstea-USGS)
W70-05014

ESTUARIES: ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
Hamburg Univ. (West Germany). Museum of Zoology.
Hubert Caspers.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p6-8, 1967. 3 p, 18 ref.

Descriptors: *Estuaries, *Lagoons, *Biological properties, *Water chemistry, Tidal waters, Fresh water, Inflow, Sea water, Biota, Boundaries (Surfaces), Mixing.
Identifiers: Poikilohalinity.

The definitions of estuaries given by Emery and Stevenson, Ketchum, and Pritchard are critically analyzed. Instability of salinity is suggested as a distinguishing factor between lagoons and estuaries. A stable body of brackish water may be considered a lagoon whereas an estuary is characterized by an unstable mixing of fresh and marine waters. The unstable conditions of estuaries determines their principal biological features. The main characteristics of estuaries are: (1) They are limited to river mouths in tidal seas; (2) the extent of saline areas in estuaries depends on the amount of fresh water inflow; (3) estuaries are characterized by instability of environmental factors and poikilohalinity. Examples of flora and fauna of an estuary are presented. (Carstea-USGS)
W70-05015

ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
Woods Hole Oceanographic Institution, Mass.
K. O. Emery.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 9-11, 1967. 3 p, 1 fig.

Descriptors: *Estuaries, *Lagoons, *Continental shelf, Sediments, Sea level, Sedimentary structures, Sands, Deposition (Sediments), Sediment transport, Radioactive dating, Sedimentation rates, Pleistocene epoch.
Identifiers: Sand ridges, Sea level rise.

This paper discusses the regional aspects of estuaries and lagoons, describes the continental shelves, and examines the sea level variations during the pleistocene epoch. Postglacial rise of sea level developed estuaries near the shelf-break, lagoons on the outer half, lagoons and estuaries near the middle, and estuaries on the nearshore part of many continental shelves. Continued rise of sea level allowed the sands to cover the shelf to the highest level of the sea. After reaching this stage, the sands will prograde back across the shelf as a succession of seaward-growing sand ridges, and perhaps offshore bars and barrier islands of lagoons. Radiocarbon dating of shallow-water shells indicates a rise of sea level from about minus 100 m 18,000 years ago to minus 20 m 9000 years ago. The rate decreased steadily from 9 m to 3 m per thousand years. (Carstea-USGS)
W70-05016

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
Washington Univ., Seattle. Dept. of Oceanography.
Donald V. Hansen.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 45-51, 1967. 7 p, 11 fig, 14 ref. Grants G19788 and GP1101. NSF Contracts Nonr 477 (10) and Nonr 477 (37). Project NR 083 012.

Descriptors: *Salt balance, *Estuaries, *Mixing, *Water circulation, Salinity, Theoretical analysis, Tidal waters, Wind tides, Wind pressure, River flow, Discharge (Water).

Identifiers: Rayleigh number, Tidal mixing, Partially mixed estuaries.

The kinematics of the mean salinity distribution and the circulation in partially mixed estuaries are discussed. Similarity and non-similarity solutions with exponential and constant salinity gradients are given. The theoretical results are in agreement with observations of river discharge, tidal mixing, width, and depth. Velocity profiles in estuaries cannot be inferred precisely from the salinity distribution alone. The nature of the velocity profile depends upon an estuarine counterpart of the Rayleigh number and this number can be determined if mean wind stress, the mean velocity at a single depth, and the river discharge are known. (Carstea-USGS)
W70-05017

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
Netherlands Inst. for Sea Research, Den Helder.
H. Postma.
In: Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 158-179, 1967. 22 p, 24 fig, 3 tab, 59 ref.

Descriptors: *Sediment transport, *Sedimentation, *Estuaries, Environment, Tidal waters, Erosion, Scour, Deposition (Sediments), Suspended load, Turbidity, Water circulation.
Identifiers: *Estuarine sedimentation, Scour lag effects, Settling lag effects.

Sediment movement and sedimentation in nearshore waters, tidal flats, and estuaries are reviewed. The main topics discussed are: (1) Erosion, transportation and deposition; (2) flocculation and deflocculation; (3) transport of suspended matter by tidal currents; (4) transport of suspended matter in estuarine circulation systems; and (5) bottom sediments. Some of the accumulation mechanisms which retain suspended matter near the coast are settling and scour lag effects. Density differences which occur in and near rivers may result in the concentration of suspended materials in turbidity maxima. Flocculation promotes the retention and sedimentation of fine-grained sediments. (Carstea-USGS)
W70-05018

03. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
General Motors Corp., Warren, Mich. Dept. of Chemistry; and Connecticut Univ., Storrs. Corrosion Research Lab.
For primary bibliographic entry see Field 08G.
W70-04550

FRESH WATER SUPPLIES THROUGH DESALINATION,
Department of the Interior, Washington, D.C.
Chung-Ming Wong.
Water Wastes Eng, Vol 6, No 11, p F-7-F-9, Nov 1969. 3 p, 3 photo.

Descriptors: *Deslaination, *Demineralization, Fresh water, Sea water, Water costs, Brackish water, Potable water, Brines, Technology, Electric power production, Nuclear powerplants, Water supply, Multiple purpose, Distillation, Corrosion, Membrane processes, Economics.
Identifiers: Cost savings, Multistage flash distill, Corrosion resistant alloys.

With the seas offering an unlimited source of water, many convincing arguments are presented for desalination. Desalting provides an entirely new source of high-quality water for needs as they arise. Potable water can be manufactured at locations and in time frames of man's own choosing without depending on the whims of nature. Desalting plants can be located in or near areas of greatest need to produce fresh water and, in some cases, electricity in a joint nuclear-powered operation. Other types of plants, using water of far less salinity than sea water, can provide modest additions to the water supply for small- and medium-sized urban areas at a pace easily adjusted to growth. Technical advances, materials development, and cost reduction that have occurred in desalination processes since 1952 are discussed. (USBR)
W70-04647

EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
Catholic Univ. of America, Washington, D.C.
H. M. Curran, and C. P. Howard.
Office of Saline Water Research and Development Progress Report No. 511, 1969. 95 p, OSW Contract 14-01-0001-1266.

Descriptors: *Freezing, Desalination Processes, Evaporation, Melting, *Salinity.
Identifiers: *Evaporative Freezing, Washing, *Batch desalination process.

A batch-type evaporative freezing process was evaluated at the bench-scale level. Saline water is sprayed into a rotating cylindrical basket at a pressure below the triple-point pressure. Removal of vapor results in formation of a semi-solid layer of ice on the later surface of the basket. The entrained brine is removed by washing and the residual ice is melted. The optimum design requires that freezing, washing and melting steps be of equal duration, and the optimum plant consists of three modules, in each of which freezing, washing and melting steps be of equal duration, and the optimum plant consists of three modules, in each of which freezing, washing, and melting operations occur in succession and out-of-phase with the other two. The heat removed by evaporative freezing in one module is used to melt the washed ice in another module. The minimum energy consumption is estimated to be 50 to 60 KWH per 1000 gallons of product at a 50 per cent conversion. Because of the amount of energy required and the complexity of the equipment the economic feasibility of the process is questionable. (Rinne-Office of Saline Water)
W70-04649

SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
Little (Arthur D.), Inc., Cambridge, Mass.
E. H. Newton, and J. D. Birkett.
OSW R and D Progr. Rept. No. 278, Aug. 1967. 71 p, 11 fig, 11 tables.
Identifiers: *Condensers, *Copper alloys, *Tubing (Metal), Cathodic projection, Equipment failures, Iron alloys, Maintenance, Operating experience, OSW sponsored, PH adjustment, Protective coatings, Scale removal, Stainless steels, Water flow.

Results are presented of survey of 56 coastal power plants using various heat-exchanger tube materials and seawater for cooling. Data were obtained on 237 tube sets of 8 different alloys. Total of 1,778,000 tubes was involved. A table summarizes results for 6 more commonly used materials based upon percent probability of tubes lasting x years with no more than y percent tubes failed.
W70-04656

SOME PRACTICAL ASPECTS OF DESALINATION BY EVAPORATION,
J. M. Stewart.
Proc. 1st Intern. Symp. Water Desalination, Wash, 1965, p 651-74, 1967. 6 fig, 9 ref.
Identifiers: *Corrosion control, *Distillation processes, *Evaporators, Brine flow, Feedwater treatment, Heat transfer coefficient, Pumps, Scale prevention, Tubing (Metal).

Distillation plants may be classified in 6 groups (1) domestic supply, (2) boiler feed and chemical processes, (3) private supply, (4) emergency supply, (5) marine use, (6) agricultural. Each group has its own set of criteria with regard to size, cost, and dependability. However, some general limitations as to size or capacity can be set out. (1) Heat transfer coefficients are effectively in the range of 450 to 550 btu/hr sq ft deg F. (2) There is a maximum useful size for the brine recirculating pump. (3) To keep the plant within practical physical limits, the brine circulation is limited to about 1 million lb/hr ft of width of evaporator shell. (4) Tubes are probably limited to 80 ft of 1-in. od tubing. (5) Brine temperature is limited to 250 deg F with acid feedwater treatment. There is much development work to be done before plants in excess of 10 mgd can be a commercial proposition.
W70-04657

ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
S. I. Golub, V. B. Chernozubov, E. A. Sobolev, and M. B. Weisblatt.
Proc. 1st Intern. Symp. Water Desalination, Wash, 1965, p 515-25, 1967. 3 fig, 3 tab, Paper SWD/79.
Identifiers: *Distillation processes, *Flash evaporation, *Multiple effect distillation, *Multistage flash distillation, Operating costs.

By analyzing multistage installations for flash evaporation and multiple effect evaporators being operated in the USSR, the product was found to cost more (5 to 8 kopecks) by flash evaporation than by multiple effect evaporation. Three reasons are given for this. (1) In a flash installation, in order to create good heat transfer at the heater-condensers, the total amount of water to be evaporated must be pumped through at a high-rate, which leads to extensive use of electric power and to a unit cost 2 to 3 kopecks more than that with multiunit equipment. (2) An increase of 1 to 1.5 kopecks must be added to the flash installation because of the acid treatment to feedwater to prevent scale formation, and (3) an increase in cost is realized for the flash process because of the larger heating surface. Flash evaporation and natural circulation evaporators have a high operational reliability. Descending film and circulation pumps require constant servicing and overhauling.
W70-04658

DEAERATORS FOR DESALINATION PLANTS.
Oak Ridge National Lab., Tenn.

OSW R and D Progr. Rept. No. 314, Dec. 1967. 117 p, 27 fig, 83 ref.
Identifiers: *Carbon dioxide removal, *Deaeration, *Deaerators, Carbon dioxide analysis, Columns (Process), Corrosion control, Fouling, Freeport plant, Oxygen analysis.

An interim report on the deaerator study is presented outlining the state-of-the-art information on existing deaerators, research and test work performed by OSW contractors and availability of commercial deaerators. Technical literature survey revealed very little information on mass transfer technology related to problems of designing deaerators for seawater. Experimental work by M. W. Kellogg Co. has attempted to evaluate conventional two-phase exchange technology to seawater. Recommendations are made to undertake a test program to evaluate the performance of the most promising deaeration methods.
W70-04659

CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
Aqua-Chem, Inc., Milwaukee, Wis.
A. B. Steinbruchel.
Preprint SM-113/29 of Paper Presented at IAEA Symp. Nucl. Desalination, Madrid, Spain, Nov. 18-22, 1968. 12 p, 4 fig.
Identifiers: *Clair Engle plant, *Flash evaporation, *Scale prevention, Brine concentration patio,

Component designs, Corrosion control, Feedwater treatment, Flowsheets, Performance ratio.

Designed and built by Aqua-Chem, Inc., the Clair Engle multistage multieffect flash plant at San Diego, with 3 recycle effects and 68 stages, is operating at a performance ratio better than 20 to 1, a 50% higher gain ratio than any other plant in the world. Guaranteed to operate and produce 1 MGD with a maximum brine temperature of 250 deg F, the equipment is designed for future operation with brine temperatures up to 290 deg F, increasing capacity to 1.23 MGD. Devised primarily to avoid calcium sulfate scaling conditions over a wide range of temperatures while minimizing feedwater quantity and treatment costs, the MEMS process permits operation of the flash plant at both higher brine terminal temperature and higher final brine concentration than other flash evaporator systems. To control and minimize corrosion of evaporator materials the plant operates with a two-stage atmospheric degasification followed by a vacuum deaeration system to liberate corrosive gases from acidified seawater. Flow schemes, plant auxiliary systems, and components are described in detail.
W70-04660

DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
California Univ., Berkeley.
G. Klein, K. M. Makar, B. W. Tleimat, and T. Vermeulen.
Sea Water Conversion Lab. Rept. No. 68-2 (Water Resources Center Desalination Report No. 25), September 1968. 59 p, 12 fig, 10 tables, 31 ref.
Identifiers: *Freedwater treatment, *Removal from feedwater, Calcium, *Scale prevention, Capitalized costs, Conceptual designs, Concrete construction, Demineralizers, Ion exchangers, Ion exhanging.

Ion exchange is used for the removal of calcium from seawater, followed by acidification and deaeration to eliminate carbonate ions. Regeneration of the ion-exchange bed is accomplished by using only the reject brine from the evaporator, the brine being concentrated in the evaporation to four times the salinity of seawater. The capital cost of the installation is minimized by assuming the use of open reinforced-concrete tanks, rather than closed steel tanks, for the ion-exchange beds. The designs of the ion-exchange installation and of its operating cycle are based on a body of pertinent experimental data obtained previously in this laboratory. The design study has resulted in an estimated cost for calcium removal of 3.6 or 3.8 cents/1000 gal of product from the evaporator, based on respective interest rates of 3.125 or 4.125% on the depreciated plant investment. Since this pretreatment leads to more economic distillation conditions, the attendant savings should largely offset the costs of pretreatment.
W70-04661

DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
Oak Ridge National Lab., Tenn.
S. J. Ball, N. E. Clapp, B. Squires, and R. Van Winkle.
ORNL-TM-2188, July 8, 1968. 69 p, 37 fig, 25 ref.
Identifiers: *Multistage flash distillation, *Plant dynamics, AEC sponsored, Dynamic response, Exerimental data, Frequency response, Instrumentation, Mathematical models.

Dynamics experiments were performed on the three-stage AMF flash evaporation at Millstone Point, Conn., in June 1967 to verify theoretical calculations of large MSF plant dynamic behavior. Frequency response tests were run at operating temperatures between 100 and 140 deg F, tray-brine flowrates between 400,000 and 700,000 lb/hr per foot of width, and with both plain and baffled interstage orifice designs. Pseudorandom binary sequences were used as input perturbation signals for the recirculating brine and brine heater steam flow control valves. The measured results indicate that the fixed-coefficient, single-phase flow orifice equation is inadequate for describing transient interstage orifice flowrates. Improved models were derived for the tray brine vaporization rate and flow dynamics. The scope of the experiments was reduced due to equipment difficulties and to excessively large inherent temperature fluctuations under certain operating conditions.
W70-04662

NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
Tennessee Univ., Knoxville.
T. W. Kerlin, J. W. Prados, W. C. Wright, and E. L. Mohundro.
Neut-2906-2, July 1968. 30 p, 11 fig, 7 ref.
Identifiers: *Evaporation dynamics, *Mathematical models, *Multistage flash distillation, Flow distribution, Fluid dynamics, Stability analysis.

Progress is reported in developing mathematical models for describing tray brine flow in an MSF stage. A scale model of a 5-stage test chamber was constructed, and proposed test procedures and equipment are described. A mathematical model for two-region brine-tray liquid flow is developed, and theoretical results are presented. A summary is given of a method for computing the linear stability of very large systems, with application to a large MSF plant. A detailed description is in NEUT-2806-3 (see abstract 30-00657).
W70-04663

PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
Delaware Univ., Newark.
A. P. Colburn.
Inst. Mech. Engrs., London, Proc, Vol. 164, p 448-58, 1951. 14 fig, 36 ref.
Identifiers: *Condensing , *Evaporator system design, *Evaporator-condenser system designs, *Heat transfer, Design, Design data, Feedwater heating, Film condensation, Mass transfer.

The theoretical background is outlined for condensation of pure and mixed vapors under conditions of a film-type condensate. The effect of vapor velocity is important for both pure vapors and those mixed with noncondensable gases. On the basis of the fundamental mechanism of condensation involved, approximation procedures are developed which are useful as quick methods of estimating and rough checking. It is concluded that there is great need for testing theoretical and approximate methods against full-scale performance data.
W70-04664

AN INVESTIGATION ON THE DISTILLATION OF BRINE BY VERTICAL TUBE EVAPORATION UTILIZING THE SEPHTON FLASH TUBE (VORTEX TUBE) PROCESS,
California Univ., Berkeley.
H. H. Sephton.
OSW R and D Progr. Rept. No. 361, June 1968. 44 p, 22 fig.
Identifiers: *Falling film evaporation, *Twisted tapes, Flow control, Heat transfer improvements, Proprietary process.

Design and construction of a vertical tube evaporator (VTE) test facility, capable of testing pairs of distillation tubes of 1- to 3-in. diameter and up to 24 ft in length is described. A novel, proprietary vortex tube process for fluid flow control as applied to falling film flash evaporation and to vertical tube distillation by utilizing a helical insert narrower in width than the internal diameter of such tubes is reported. Heat flux gains of 20 to 80% were obtained with a vortex tube over those obtained with a reference tube, tested simultaneously under equal VTE process conditions with water having 0 to 10% sodium chloride added thereto as the distillland, in vertical copper distillation tubes of 2-in. x 20 ft dimensions.
W70-04665

DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
Office of Saline Water, Washington, D.C.; and Oak Ridge National Lab., Tenn.
E. N. Sieder, and I. Spiewak.
Preprint SM-113/34 of Paper Presented at IAEA Symp. Nucl. Desalination, Madrid, Spain, Nov. 18-22, 1968. 20 p, 5 fig, 21 ref.
Identifiers: *Component development, *Component testing, *Heat transfer improvements, *Vertical tube evaporators, Brine flow, Component designs, Concrete construction, Deaerators, Entrainment, Extended heat transfer surfaces, Flash chambers, Freeport plant, Heat transfer coefficient, Heat transfer surfaces, Pilot plant operations, Product water treatment, Wrightsville Beach plant.

The San Diego Multistage Flash Module serves as a test bed for studying brine flows up to 1,000,000 lb/hr-ft width in full-scale flash chambers, hydraulics of a 77,000 GPM recycle pump, and heat transfer and venting of large condenser bundles. Low-cost evaporator tubing fabrication methods are being developed, and tubes up to 36 ft long have been fabricated and installed in a test fixture. Deaerator designs and instruments are being developed to reduce oxygen content of treated seawater to 10 ppb. Advanced technology developement is centered around high performance evaporator tubing, especially with the multieffect vertical tube evaporator process. Fluted tube bundles at Wrightsville Beach and Freeport are maintaining heat transfer coefficients 2 to 3 times higher than those of smooth tubes. A new spiral-indented tube provides heat transfer rates 1.5 to 2 times those of smooth tubes. Full size bundles of high performance tubes will be tested in a VTE component test vehicle to be built at San Diego. Concrete is especially promising as a structural material, as tests have indicated that it will withstand brine temperatures up to 250 deg F. Plastics are promising for coatings and for special parts such as hook-vane entrainment separators. Progress is also being made in large water-only plants. Design studies have been completed of large vapor compressors and of large VC plant designs.
W70-04666

CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
Titanium Metals Corp. of America, West Caldwell, N.J.
For primary bibliographic entry see Field 08G.
W70-04667

DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
Stearns-Roger Corp., Denver, Colo.

OSW R and D Progr. Rept. No. 298, Sept. 1967. 53 p, 7 fig, 10 tables, 7 ref.
Identifiers: *Deaerators, *Feedwater treatment, *Multiple effect distillation, *Vertical tube evaporators.

The report covers an investigation of the various aspects of heat transfer and feedwater treatment and their effects on the multiple-effect long-tube-vertical evaporator. Development run no. 8 was conducted in a scale-free manner for almost two months with only one unscheduled shutdown of 1.5 hr. Production was maintained above 1 mgd with 69.5% of the originally installed heat transfer surface. Tests were completed which show that product heat recovery by flashing accumulated condensate is feasible, but the existing plant equipment imposes limitations on the maximum production rate in this mode of operation. A study of feed-

water acid addition rate to the deaerator-decarbonator showed that the quantity of acid used could be reduced about 15% without harm. Water was produced for 114.58 cents/1000 gal during the run. This value reflects a 2.69 cents/1000 gal penalty directly attributable to operating conditions imposed by the development program.
W70-04668

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
Stearns-Roger Corp., Denver, Colo.

OSW R and D Progr. Rept. No. 299, June 1968. 59 p, 17 tables, 10 fig.
Identifiers: *Deaerators, *Feedwater treatment, *Multiple effect distillation, *Vertical tube evaporators, Acid stabilization processes, Cathodic protection, Chemical additives, Corrosion control, Freeport plant, pH control, Pilot plant operations, Protective coatings, Removal from feedwater, Carbonate, Scale prevention, Status reports, Water costs actual.

The report covers an investigation of the various aspects of heat transfer and feedwater treatment and their effects on the multiple-effect long-tube-vertical evaporator. Development run no. 9 (June to Nov. 1965) consisted of over 4 months of operation with a total of 31 hours of shutdown time, and 2 of the 4 shutdowns were scheduled as part of the development program. Evaluation of test data indicates that plant insulation is deteriorating and that steam economy is suffering accordingly. Evaporator performance evaluations show that high operating temperatures and high brine flow rates enhance heat transfer coefficients. Investigation of tube side pressure drop in the evaporators has indicated that lost temperature potential due to delta p is a factor in the low pressure evaporators. It was proven that improper venting can limit the production capability of the plant and that venting adjacent effects to the atmosphere through a common line is not adequate. Water was produced for 111.93 cents/1000 gal during the run, a 3% improvement over run 8, due to higher production over a longer operating time.
W70-04669

DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
Catalytic Construction Co., Philadelphia, Pa.
For primary bibliographic entry see Field 08C.
W70-04670

RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
Aqua-Chem, Inc., Waukesha, Wis.

OSW R and D Progr. Rept. No. 209, Nov. 1966. 81 p, 33 fig, 9 ref.
Identifiers: *Dropwise condensation, *Heat transfer coefficient, *Horizontal tube evaporators, Scaling, Vapor compression evaporation.

Heat transfer coefficients on horizontal spray film evaporator were determined under a variety of operating conditions under laboratory and field operating conditions. Heat transfer coefficients were only slightly influenced by the heat and vapor velocity over the range of 3000 to 12000 btu/hr sq ft heat flux and 16.5 to 50 ft/sec average vapor velocity. Average heat transfer coefficients of 1125 and 2000 btu/hr sq ft deg F can be maintained for the 5/8-in.-copper-nickel bundle and copper bundle, respectively, on salt water without scaling for an extended period of time under vapor compression operation.
W70-04671

ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
I. L. Sergeyenko.
Proc. 1st Intern. Symp. Water Desalination, Washington, 1965, p 373-88, 1967. 24 fig, Paper SWD/71.
Identifiers: *Distillation processes, *Multistage flash distillation, *Seeding processes, *Vertical tube evaporators, Direct contact heat exchange, Feedwater treatment, Flash evaporation.

The two main processes for large-scale distillation plants are vertical tube evaporation and multistage flash distillation (with either condenser tubes or contact condensation). Scale formation is a basic problem in any of the processes. In USSR the most economical scale prevention method is a seeding process. Numerous graphs are given to show the effect of the number of stages in a plant on the cost of product water for the different distillation processes.
W70-04672

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
Tennessee Univ., Knoxville.
W. C. Wright, and T. W. Kerlin.
Ph.D. Thesis. Neut-2806-3, July 1968. 172 p, 27 fig, 88 ref.
Identifiers: *Multistage flash distillation, *Plant dynamics, *Reactor dynamics, AEC sponsored, Frequency response, Programs (Computers), Stability analysis.

The development and application of a technique is described for evaluating the stability of multivariable systems whose dynamics are given by up to 1000 first-order, linear differential equations. Time-lagged variables may be included in these equations. The technique is an analytical approach which operates on the coefficients of the equations that describe the system. The method is based upon a modification of the Mikhailov (Leonhard-Cremer) stability criterion and employs special programming techniques which take advantage of the form of the system equations. Among the systems analyzed for stability were the molten salt reactor experiment, a molten salt breeder reactor, and the evaporator, heater, and heat reject components of a multistage flash evaporator plant. Computer programs written in FORTRAN IV are included. The analysis of the multistage evaporator plant required about 1.5 hr on the IBM 360/75 computer.
W70-04673

CONCEPTUAL DESIGN STUDY OF A ONE MILLION GALLON PER DAY MSM DESALINATION PLANT - REPLACEMENT FOR DEMONSTRATION PLANT NO. 2 AT POINT LOMA, SAN DIEGO, CALIFORNIA.
Fluor Corp., Ltd. Los Angeles, Calif.

OSW R and D Progr. Rept. No. 252, Apr. 1967. 147 p, 28 fig.
Identifiers: *Conceptual designs, *Multiple effect distillation, Concrete construction, Construction costs, Deaeration, Design, Distillation processes, Feedwater treatment, Flash evaporation, Fossil fuels, Point Loma plant, Scale prevention, Seeding processes, Tube bundle design, 0-50 MGD plant.

Results are presented of a conceptual design study are presented for a 1.0-MGD multieffect flash plant at Point Loma. The design is essentially a 1/50th slice of an optimum conceptual 50-MGD plant and is intended to demonstrate major design features. The base plant (68 flash stages) operating temperature is 250 deg F, with flexibility to operate experimentally at 290 deg F. A special 1A effect, to operate independently, is provided to yield operating experience in the 290 to 350 deg F range. The design provides for study of brine flow path variations, measurement of instage temperatures and pressures, and study of concrete shell performance. The vertical height of the effect II and III tube bundles is representative of large-capacity plants. Acid treatment provides alkaline scale control. Auxiliary seeding, lime magcarbonate, and ion exchange systems provide sulfate scale control at extended operating conditions. Capital cost estimates (1965 basis) are $2,950,000 for the base plant, $225,000 for the 1A effect, and $1,170,000 for water treatment systems.
W70-04674

COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
Applied Research and Engineering Ltd., Durham (England).

IAEA Tech. Rept. Ser. No. 93, 1968. 73 p, 35 fig, 31 ref.
Identifiers: *Economic evaluations, *Energy sources, *Single-purpose plant economics, *Water costs estimate, Dual-purpose plant economics, Fossil fuels, Gas-cooled fast-breeder reactors, High-temperature gas-cooled reactors, Nuclear energy sources, Pressurized-water reactors, Single-purpose plant.

The cost of water from a single-purpose MSF/recompression plant is presented and compared with the cost of water from dual-purpose plant. It also shows the cost of water from a plant producing both water and power separately from a common reactor. It was found that for a single-purpose plant with recompression the estimated water costs ranged from 30 cents/1000 gal for a 350-MGD plant with a light-water reactor (at 6% charge rate) to 92 cents/1000 gal for a 70-MGD plant with a gas-cooled reactor (at 15% charge rate). Estimates are given for 70 and 350-MGD plants, 6 and 15% charge rates, and light-water reactors, fast reactors, gas-cooled reactors, high-pressure steam fossil plants, and low-pressure fossil plants. A direct comparison between the proposed system and a dual-purpose plant cannot be made because of the effect of the cost of electrical power on the water cost from a dual-purpose plant.
W70-04675

THERMAL DISTILLATION OF SEA WATER - FUNDAMENTALS OF THE THEORY OF MARINE EVAPORATORS,
V. F. Kovalenko.
AEC-TR-6893, Sept. 1967. 230 p, 155 ref. Translated from Russian, Transport Publishing House, Moscow, 1966.
Identifiers: *Distillation processes, Energy sources, Flash evaporation, Heat transfer, Physical chemistry of scale, Scale prevention, Thermodynamics.

This translation of the Russian book covers distillation for use aboard ships, mostly theory and background. The chapters are: (1) Fundamentals of thermal distillation, (2) Sources of heat and selection of types of shipboard evaporator installations, (3) Fundamental principles of the theory of heat exchange in thermal distillation, (4) Methods of reducing the thermal resistance of the scale in marine evaporators, (5) Fundamentals of design and calculation in thermal distillation, (6) Automation of thermal distillation on ocean vessels, (7) Ways of increasing evaporator efficiency.
W70-04676

SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
Office of Saline Water, Washington, D.C.
D. I. Dykstra.
Chem. Eng. Prog. Vol. 61, No. 7, p 80-88, 1965. 12 fig, 15 ref.
Identifiers: *Falling film evaporation, *Freeport plant, *Vertical tube evaporators, Distillation processes, Feedwater heating, Heat exchangers, Heat transfer, Heat transfer improvement, Heat transfer surfaces, Multiple effect distillation, Pilot plant operations.

A description is given of the operation of various heat transfer units in the first OSW desalination demonstration plant (built 1960-61 at Freeport, Texas). The plant is of the long tube vertical (LTV)

falling-film type with forward feed and 12 evaporator effects. Boiler plant steam supplies heat in the first effect. Most of the feedwater evaporated in the first effect heats and evaporates the feedwater in the second effect evaporator, being condensed by this process, and the remainder is condensed as it gives up its heat to the incoming feedwater. The discharged brine from the first effect becomes the feed for the second effect. This process is repeated in 11 additional evaporator effects at progressively lower temperatures and pressures down to 115 deg F and 1.9 PSIA in the twelfth effect. The evaporated water from the last effect is condensed by heat exchange with seawater. For every pound of steam 11 lb of fresh water are produced. Electric power consumption is about 1 kw-hr/1000 lb of fresh water production. Total energy consumption is about 115 btu (thermal)/lb of water produced. Operating temperatures have been successfully increased to 278 deg F and overall plant temperature range to 160 deg F. Equivalent production rates of 180% of rated capacity have been demonstrated. Work is continuing with the anticipation of reaching and exceeding 300 deg F operation.
W70-04677

FLOW THROUGH IRRIGATED DUMPED PACKINGS--PRESSURE DROP, LOADING, FLOODING,
M. Leva.
Chem. Eng. Progr. Symp. Ser. , Vol. 50, No. 10, p 51-59, 1954. 10 fig, 21 ref.
Identifiers: *Columns (Process), *Deaeration, *Deaerators, Aeration, Carbon dioxide removal, Feedwater treatment, Removal from feedwater, Carbonate.

Loading and flooding in packed irrigated towers and the relation of these phenomena to pressure drop are discussed. Empirical equations which permit pressure-drop estimations in the preloading range are given, and extensions of these equations to liquids other than water are made. In order to estimate the pressure drop in the loading-flooding zone, for which the equations will give low results, a generalized isobaric plot was prepared. The graphical presentation includes most of the loading data in the literature, and the chart indicates not only the state of loading of an irrigated tower but also the expected pressure drop. The correlation of the data pertaining to water, sucrose solution, and oils led to a slight modification of the generally accepted flooding correlation. Analysis reveals that incorporation in the ordinate of the density ratio of water to that of the irrigating liquid considerably improves the presentation of the data.
W70-04678

OPERATING EXPERIENCE AT THE MULTI-STAGE FLASH DEMONSTRATION PLANT, POINT LOMA, CALIFORNIA,
Westinghouse Electric Corp., Philadelphia, Pa.
R. E. Gaunt.
Water Production Using Nuclear Energy (Ed. by R. G. Post and R. L. Seale), p. 135-44, 4 fig, Univ. Arizona Press, Tucson, 1966. Proc. Am. Nucl. Soc. Symp., Mar. 1966, Tucson, Ariz.
Identifiers: *Operating experience, *Point Loma plant, Feedwater treatment, Multistage flash distillation, Pilot plant operations, Scale prevention, 0-50 MGD plant.

The 1-MGD, 36-stage flash evaporator demonstration plant operated from Nov. 1961 until early 1964. At this time it was dismantled and reassembled at the Guantanamo Naval Base in Cuba. A brief description of the plant and its demonstration features is given. Operation of the plant was quite satisfactory with mechanical difficulties, confined mostly to pumps and peripheral equipment, causing some interruptions during the first year of operation. Initial operation was with polyphosphate feedwater treatment which permitted operation at 200 deg F. A change to an acid treatment system permitted operation at 250 deg F and it was possible to increase the production rate to 1.4 MGD. Experience at Point Loma and other installations allows some confident predictions to be made about the future costs of producing potable water by the multistage flash process. Product cost was about $1.25/1000 gal when operating at 200 deg F but this dropped to about $1.00/1000 gal when the production rate was increased to 1.4 MGD. Studies show that with present-day technology large amounts of water can be produced for 25 to 35 cents/1000 gal in large dual-purpose plants.
W70-04679

CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
Midwest Research Inst., Kansas City, Mo.
E. P. Shea, and W. R. Hollingshad.
OSW R and D Progr. Rept. No. 166, Dec. 1965. 129 p, 243 fig, 38 tab.
Identifiers: *Carbon steels, *Pitting (Corrosion), *Tubing (Metal), *Wrightsville Beach plant, Aeration, Corrosion, Corrosion tests, Deaeration, Heat transfer, pH control, Physical chemistry of scale, Pilot plant operations, Scaling, Seawater chemical analysis, Temperature control.

Results are described from operation of two distillation pilot plants at Wrightsville Beach to investigate effects of dissolved oxygen, pH, heat transfer rates and tube surface condition on corrosion of carbon steel evaporator tubes in seawater at temperatures to 250 F. It was concluded that steel tubes are not suitable for evaporator effects above atmospheric boiling. However, decarbonation and deaeration are essential for inhibiting scale formation and minimizing corrosion. Seawater pH should be maintained above 8. Greater corrosion was experienced at pH 7 than at pH 8. Tube surface condition had no appreciable effect on corrosion. The rate of heat transfer did affect corrosion. Greater corrosion occurred at the higher heat transfer rates unless scale formation inhibited attack. Scale formation was a problem at the higher Delta temperatures. At Delta temperatures of 12-16 F, scale formation was accelerated. Complete tabular data are presented for aerated and deaerated seawater systems on corrosion rates, tube penetrations, scale weights and analyses, and composition of Wrightsville Beach seawater.
W70-04680

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
Kansas State Univ., Manhattan.
L. T. Fan, C. Y. Cheng, C. L. Hwang, L. E. Erickson, and K. D. Kiang.
Desalination Vol 4, p 336-60, 1967, 13 ref. Also part of special Report No. 74, Kansas Engineering Experiment Station, Manhattan, Kansas (1967).
Identifiers: *Mathematical models, *Multiple effect distillation, *Multistage flash distillation, Design, Distillation processes, Heat balance, Material balance.

A mathematical model of a multieffect multistage flash distillation system that can be used in process optimization studies is developed. The model enables the heat input to the brine heater, the recycle flow rate in each effect, the concentration and temperature of the flashing brine leaving each effect, and the number of stages in each effect to be treated as variables in an optimization study. The model is believed to be accurate enough to describe the process, yet simple enough to be used in the simulation, design, and optimization of the process.
W70-04681

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
Kansas State Univ., Manhattan.
L. T. Fan, C. Y. Cheng, C. L. Hwang, L. E. Erickson, and K. D. Kiang.
Desalination Vol. 4, p 361-88, 1968. 13 fig, 14 ref. Also Part of Special Report No. 74 Kansas Engineering Experiment Station, Manhattan, Kansas, 1967.
Identifiers: *Mathematical models, *Multiple effect distillation, *Multistage flash distillation, Design, Distillation processes, Heat balance, Material balance.

A mathematical model of a multieffect, multistage flash distillation system that can be used in process optimization investigations has been developed in Part I of this work. In the present part, the model is used together with an economic model of the system to minimize the cost of water production. The heat input to the brine heater per unit of feed, the recycle flow rate in each effect, and the concentration and temperature of the flashing brine leaving each effect are chosen so that the water production cost is a minimum.
W70-04682

CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
Oak Ridge Gaseous Diffusion Plant, Tenn.; and Office of Saline Water, Washington, D.C.
S. J. Senatore, and E. N. Sieder.
Preprint SM-113/33 of Paper Presented at IAEA Symp. Nucl. Desalination, Madrid, Spain, Nov. 18-22, 1968. 12 p, 5 fig, 3 ref.
Identifiers: *Conceptual designs, *Dual-purpose plant, *Heavy-water/organic-cooled reactors, *Single-purpose plant, *Southwest United States, Fixed charge rate, Municipal financing, Performance ratio, Turbine-generators, Vapor compression evaporation, Vertical tube evaporators, Water costs estimate, 250 plus MGD plant, 3000 plus MW (T) reactors.

To determine their potential for meeting long-range water and power requirements of the southwestern U. S., conceptual designs and cost estimates were prepared for a water-only and a dual-purpose plant, both with fresh water capacities of 750 MGD. The single-purpose plant consists of a 3962 MWT heavy-water moderated organic-cooled reactor coupled to a vapor compressor, vertical tube evaporator plant and is designed for a performance ratio of 20.40 lb product/1000 btu and 250 deg F maximum brine temperature. The dual-purpose plant consists of a 10,027 MWT HWOCR designed for a performance ratio of 10.47 product/1000 btu and for a maximum brine temperature of 250 deg F. Auxiliary power requirements at the site are estimated to require 275 MWE, leaving 1870 MWE available for sale and offsite product water conveyance. Based on municipal-type financing, with an annual fixed charge rate of 6.597%, the average cost of product water from the single-purpose plant at the plant boundary is estimated at 22.24 cents/1000 gal and at 18.47 cents/1000 gal for the reference dual-purpose plant.
W70-04683

ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
Kaiser Engineers, Oakland, Calif.
F. L. Harris, G. B. Humphreys, H. Isakari and G. Reynolds.
Office of Saline Water Research and Development Report 509, 1969. 505 p. OSW Contract 14-01-0001-1669.

Descriptors: *Desalination, *Reverse osmosis, *Membrane processes, Cost optimization, Plant design.
Identifiers: *Desalination apparatus, Membranes, Computer algorithm, Economics.

A parametric engineering and economic analysis of the reverse osmosis process was performed in which water costs were examined for demineralizing feedwaters with salinities of 2000, 3000 and 5000 ppm in plant sizes of 1, 10 and 50 mgd capacity, product water recoveries of 50, 60 and 80%, and operating pressures of 400, 600 and 800 psi. Capital and operating costs were prepared using state-of-the-art technology for tubular, plate-and-frame, spiral wound, and hollow fine fiber reverse osmosis plant design concepts. Mathematical

models were prepared to represent the hydrodynamic characteristics of each design concept. These models, in conjunction with computer codes were used to optimize plant design and operating parameters. Plant capital and operating costs were also prepared on the basis of anticipated improvements in reverse osmosis technology. (Mintz-Office of Saline Water)
W70-04889

VACUUM FREEZING VAPOR COMPRESSION PROCESS: EVALUATION ON BRACKISH WATER,
Colt Industries, Inc., Beloit, Wis.
M. M. Jhawar, and J. H. Fraser.
Office of Saline Water, Research and Development Progress Report No. 541, April 1970. 46 p. OSW Contract 14-01-0001-967.

Descriptors: *Desalination processes, *Freezing, Brackish water.
Identifiers: *Vacuum freezing, Mobile unit.

A mobile vacuum freezing vapor compression (VFVC) pilot plant was designed, built and operated at its design capacity on both sea and brackish water. Tests were conducted at Roswell, New Mexico on 15,000 ppm well water. This water was very high in calcium sulfate. No scaling or precipitation were observed. Based on this work it is concluded that the VFVC process can be used to desalt any brackish water without the necessity of pretreatment.
W70-04890

DISPOSAL OF BRINE BY SOLAR EVAPORATION: LABORATORY EXPERIMENTS,
New Mexico State Univ., University Park.
For primary bibliographic entry see Field 05E.
W70-04891

DISPOSAL OF BRINE BY SOLAR EVAPORATION: DATA,
New Mexico State Univ., University Park.
For primary bibliographic entry see Field 05E.
W70-04892

RELATIONSHIP BETWEEN STORAGE CAPACITY AND LOAD FACTOR OF A DESALINATION PLANT,
Department of Economic and Social Affairs (UN).
A. R. Golze.
Proc, Int Seminar Econ Appl Water Desalination, p 185-205, September-October 1967. 21 p, 9 fig, 2 tab.

Descriptors: *Storage capacity, *Desalination plants, Optimization, Load distribution, Water supply, Computers, Models, Costs, Economics, California, Programs.
Identifiers: Storage facilities.

Relationships involved in comprehensive studies to determine the economic selection between alternative water supplies were discussed. Several typical situations in which a desalter might be justifiably involved in water supply and the utilization of its output were analyzed. The case where the desalter was the sole source of supply was selected to illustrate the type of optimization that could be accomplished. The relationship between storage capacity and the desalting plant load factor was derived and programmed for computer solution. An optimization model was developed and used to determine the operation of the desalination plant. A discussion of different types of storage facilities and of representative average cost of such storage facilities in California was presented. (Thiuri-Cornell)
W70-04905

ENGINEERING ASPECTS OF A NUCLEAR DESALTING PLANT,
Burns and Roe, Inc., New York.
J. G. Perri.
J. Power Div., Am. Soc. Civil Engrs., Vol 93 (PO1), p 31-50, 1967.
Identifiers: *Modular construction, Dual-purpose plant, Flash chambers, Flash evaporation, Layout, Multistage flash distillation, Nuclear desalination.

The dual-purpose plant is a transformation of the simple nuclear power and desalting plants but contains new elements conceptually different from the analogous elements in those simple plants and has special characteristics which greatly affect the design. One of the most important characteristics is the multistage controlled evaporator, that is, the complex of stages vertically assembled containing thin film evaporators. The problem posed by the modular concept required considerable study and technical background, the resulting coordinate procedure for the general assembly of the modules will produce a vessel-structure concept. The structural system is a central feature of great interest. Basically, it can be classified as an orthotropic plate system, however, its dual function of being a pressurized vessel and a supporting structure makes it an unusual engineering project.
W70-04925

FLASH DESALINATION PLANT - THE RESULTS OF THE FIRST TEN YEARS OF DEVELOPMENT AND FIELD PROVING,
Buckley and Taylor Ltd., Oldham (England).
W. Smith.
Water Eng. Vol. 69 (837), p 458-62, 1965. 5 fig.
Identifiers: *Distillation processes, *Reviews, Corrosion control, Instrumentation, Product ratio, Pumps, Scale prevention, Water utilization.

A variety of field-proved designs are currently available, providing a wide range of sizes of distillation plants with outputs from 2000 GPO to nearly 2 MGD. Considerable variation in performance ratio is available within the range 1.5/1 to 8/1, allowing the user a measure of control over the cost of the converted water. Perhaps the most significant proved application available today is the dual-purpose plant, since there is generally a need for increased power wherever there is a need for more water. In ten years the total of land-based distillation capacity has increased from 8 MGD to 40 MGD. Currently, the largest single unit operating commercially is about 1.5 MGD. However, design thought should be given to 50 to 150 MGD plants. Work is now in progress to study such problems as scale suppression techniques, corrosion/erosion prevention, automatic controls, and pumping problems. In many cases we cannot afford to wait for the final lowest cost water. Users and manufacturers should acknowledge that assessing future massive demands for water and large-scale conversion will only come several years hence. The world is thirsty now and this thirst must be quenched with water conversion equipment of present-day field-proved design.
W70-04926

INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
L. A. Minuhin, V. B. Chernozubov, E. P. Emelina, A. A. Bolotov, and Z. M. Romanova.
Desalination, Vol 2, p 337-44, 1967. 4 fig, 6 ref. Also preprints from 2d European Symp.-Fresh Water from the Sea, Vol 2, Athens, May, 1967.
Identifiers: *Chemical additives, *Condensation promoters, *Dropwise condensation, Film condensation, Heat transfer coefficient, Heat transfer improvements.

Silicoorganic hydrophobizing liquids, copper and chrome oleates, machine oil, and paraffin were tested as dropwise condensation promoters. In the runs, copper, brass, and copper-nickel tubes of 8-40 MM OD and 0.3-5 M lengths were used. The runs were made with condensing steam under atmospheric pressure, introducing the promoter on the heating surface by bubbling steam through a solution of the promoter. Conclusions reached were (1) in the condensation of commercially polluted steam, promoter life is sharply reduced in comparison with its life using pure steam, (2) the reason for this reduction is the deposition of impurities of insoluble particles from polluted commercial steam on the hydrophobic surface, (3) continuous stable dropwise condensation is obtained by the continuous dosage of promoter as well as by periodical dosage at intervals in which good dropwise condensation is still maintained, (4) in the creation of dropwise condensation, decrease of drop size of a promoter in the steam permits use of smaller promoter doses, and (5) there is a definite range of optimal promoter concentrations in the bubbler at which the highest intensity of heat exchange at minimum promoter doses is obtained.
W70-04927

TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
V. B. Chernozubov, E. P. Novikov, V. V. Kartovski, S. I. Golub, and V. G. Shatsillo.
Preprint from 2d European Symp.-Fresh Water from the Sea, Vol 2, Athens, May, 1967. 6 p, 1 fig.
Identifiers: *Seeding processes, *Chemical additives, Distillation processes, Feedwater treatment, Flash evaporation, Heat transfer coefficient, Multistage flash distillation, Pilot plant operations, Scale prevention, Scaling.

With water from the Caspian Sea, which has approximately the same composition of scale-forming ingredients as the ocean, tests were conducted in a small pilot flash plant to determine optimum conditions for scale prevention by the seeding process, which is simpler and less expensive than the more commonly used acidification. The plant consisted of a seven-stage flash evaporator, a main heater and a clarifier. Common ground chalk was used as the seeding agent. In the first series of experiments the seawater was heated to 115 and 125 deg C, and scale formation was retarded but not eliminated. Scale deposited intensively in the main heater and more formed on the exit parts of the tubes than on the entrance parts. The heat transfer coefficient was reduced by 50 to 60%. A second series of tests conducted with seawater heated to 95 and 105 deg C proved 95 deg to be the most practicable, although some problems were encountered due to water foaming in the stages. At 105 deg the heat transfer coefficient remained constant for the whole test period, but a thin film of scale formed on heating tubes. Experiments will be continued in an effort to develop operating conditions and seed composition which will provide scale-free heat exchange surfaces at higher seawater temperatures.
W70-04928

ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
Battelle Memorial Inst., Columbus, Ohio.
For primary bibliographic entry see Field 08G.
W70-04929

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
Oak Ridge National Lab., Tenn.
C. C. Littlefield, D. M. Eisenbert, and S. A. Reed.
ORNL-TM-2415, March, 1969. 34 p, 11 fig, 11 ref.
Identifiers: *Feedwater treatment, *Removal from feedwater, Carbonate, *Scale prevention, Bench scale, Carbon dioxide addition process, Carbon dioxide removal, Distillation processes, Experimental data, Seeding processes.

An investigation into the use of carbon dioxide for preventing scale in distillation-type desalination plants is in progress. Small-scale experimental work has been carried out with seawater in a 6-in.-dia combined flash decarbonator and scale precipitator in Wrightsville Beach and with fresh and salt water in 2-in.-dia countercurrent gas-liquid stripping columns in Oak Ridge. The experimental work has shown (1) that scale can be prevented in brine heater tubes by injecting carbon dioxide into cold brine prior to heating, (2) that the carbon dioxide may be removed by countercurrent

stripping of the hot carbonated brine with either air or steam, and (3) that the alkaline scale which precipitates upon removal of the carbon dioxide can be preferentially collected on solid surfaces such as the stripping column packing or on a high-surface-area solid such as activated alumina. The alkalinity of the exit seawater from the decarbonator has been reduced from the inlet value of about 110 ppm to as low as 20 ppm equivalent calcium carbonate. Further testing is required to define the design parameters for large desalination plant scale suppression systems.
W70-04930

TITANIUM TUBES NOW FIGHT SEA WATER,
Harvey Aluminum, St. Croix, Virgin Islands.
For primary bibliographic entry see Field 08G.
W70-04931

A NEW RIVAL FOR FLASH DISTILLATION,
J. P. Lynam.
Power, Vol 112, No 9, p 79, 1968.
Identifiers: *Vapor compression evaporation, *Water costs estimate, Distillation processes, Economic evaluations, Multistage flash distillation, Proposals, Roswell Plant.

The vapor compression method for water desalting has not had the study it deserves. An OSW study of a 1-MGD plant lists water costs as $1,20/1000 gal for flash distillation, $1.35 for falling-film evaporation, and $1.57 for vapor compression. The study considers electrical power for vapor compression at 1 cent/KWH. However, an on-site diesel generator can provide power for less than half this figure. Also waste heat from such a diesel engine could be used to produce 43% additional product water. This would bring the product cost by vapor compression down to $0.98/1000 gal. It is unfortunate that these simple modifications were not incorporated into the Roswell Vapor Compression Plant. A gas-turbine vapor compression unit might lead to further cost reductions. We should reconsider the supposedly uneconomic vapor compression process in a new light.
W70-04932

DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
Struthers Energy Systems, Inc., Warren, Pa.; and Pratt and Whitney Aircraft, East Hartford, Conn.
H. Wightman, E. G. Rorstrom, F. C. Standifor, C. A. Bassilakis, and R. W. Foster-Pegg.
OSW R and D Progress Report No. 377, July, 1968. 292 p, 46 fig, 12 ref.
Identifiers: *Extended heat transfer surfaces, *Gas turbines, *Vertical tube evaporators, *Waste heat boilers, Compressors, Conceptual designs, Design, Direct costs, Economic evaluations, Falling film evaporation, Heat recover, Single-purpose plant economics.

The study of two sizes of gas turbine drivers was conducted and a 12,500 SHP, dual shaft, gas turbine driver was chosen as the main power train. The plant is designed to produce 8.0 MGD. The cycle uses a VTE and a MSF unit in series. The gas turbine driven axial flow vapor compressor operates across 4 effects of the VTE. Gas turbine exhaust heat is recovered in a heat recovery boiler. Only on-site power is generated in the back pressure turbine rated for 1500 kw. The water cost developed for the plant is $.39/1000 gal. The total capital cost of the plant is approximately $7,500,000. Drawings showing VTE tube sheet configurations and general outlines are provided. A heat and material balance is provided. Vendors bids received for plant equipment are provided.
W70-04933

EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
Technische Hogeschool, Delft (Netherlands).
FCAA Van Berkel, J. W. Van Hasselt, and J. H. Van der Torren.
Proc. Intern. Symp. Water Desalination, 1st, 1965, Washington 3, 189-212 (1967), 9 fig, 7 tables, 8 ref, paper SWD/94.
Identifiers: *Design data, *Flash evaporation, *Operating experience, Flowsheets, Layout, System descriptions.

The sources of information are the once-through evaporator of the Compania Shell de Venezuela refinery at Cardon, Venezuela, two brine recirculation evaporators of the government waterworks off the Island of Curacao (Netherlands Antilles), and the brine recirculation-distillate reheat evaporator of the Shell Curacao N.V. Refinery at Emmastad, Curacao. Flow diagrams and design data of the three evaporators are given. The specific heat consumption immediately after cleaning the evaporators was 5 to 15% higher than the design value (which already included a margin for fouling). The experiments showed that temperature indicator pockets should be installed in every flash chamber and in every water box to indicate poorly working flash chambers or condensers and pressure indicators should be installed in each stage to locate noncondensible gases.
W70-04934

COMBINED RECOVERY OF POTABLE WATER AND SEA SALT BY EVAPORATION an economic solution,
T. Messing.
Proceedings, 1st Intern. Symp. Water Desalination, 1965, Washington paper SWD/96, p 573-94, 1967. 12 fig, 4 tables, 11 ref.
Identifiers: *Economic evaluations, *Evaporators, Capitalized costs, Flash evaporation, Operating costs, Scale prevention, Scaling, Water costs estimate.

The operating conditions and a flow diagram of a messo desalting plant incorporating a 3-stage forced circulation evaporator installed in Kuwait (as a subsequent stage to a flash evaporation plant) are given. Scaling by calcium sulfate can be avoided either by chemical treatment of the preconcentrated seawater or by controlled precipitation of the calcium sulfate, using seeding techniques, during further concentration. The results of solubility isotherm investigations of salt in seawater of the Mediterranean at 40, 60, 80 and 100 deg C are given. The most efficient plants were found to be forced circulation evaporators of 10 to 20 stages and flash evaporators of 30 to 40 stages. After two years of operating the Messo plant (potable water output of 272 tons per day), it was found to operate according to design specifications. Total capital costs for an 8-stage flash crystallization plant for the recovery of salt are $7,254,000, including working capital costs of $350,000 for 60 days production. Potable water can be produced at a price ranging between DM 0.40 and DM 0.80 per cubic meter if the production costs come to DM 30 per ton sodium chloride and if a sales price of DM 70 per ton sodium chloride is calculated.
W70-04935

THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
Dartmouth Coll., Hanover, N.H.
M. Tribus, and R. B. Evans.
Proceedings, 1st Intern. Symp. Water Desalination, 1965, Washington, p 699-720, 1967. 6 fig., 4 tables, 18 ref.
Identifiers: *Distillation processes, Dual-purpose plant, *Economic evaluations, Energy costs, Thermodynamics, *Water costs estimate.

The costs of condensation-evaporation in a thermal or mechanical distillation system for seawater are 19.5 and 23.8 cents/1000 gal, respectively. The cost of electrodialysis for brackish water is 9.9 cents/1000 gal and for seawater is 80 cents/1000 gal. The cost of reverse osmosis is 32.2 cents/1000 gal. Figures indicate that the cost of steam (in a dual-purpose plant) drawn directly from a boiler (or superheater) is relatively independent of temperature over the range of steam temperatures normally occurring in power plants. The price structures for a linear plant with a fixed external price structure, for a liner plant with variable unit area cost, and for a plant with nonlinearity and variable price structure are given.
W70-04936

OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
Baldwin-Lima-Hamilton Corp., Eddystone, Pa.
R. A. Tidball, A. N. Rogers, G. Levite, and R. E. Woodbury.
OSW R and D Progress Report, No. 288, Oct., 1967. 106 p, 26 fig, 9 ref.
Identifiers: *Pilot plant operations, *Scale prevention, Blowby, Chemical additives, Flash evaporation, Heat transfer coefficient, Protective coatings, Scale removal, Scaling, Seeding processes, Tubing (Metal), Turbulence promoters.

Operation as a module of a typical commercial plant has confirmed the existence of a kinetic effect in the formation of calcium sulfate scale. The severe conditions imposed by this method of operation cause rapid changes in the heat transfer coefficient, permitting incipient scaling to be detected in a short run. A criterion is given to evaluate scale formation by means of changes in heat transfer coefficients, and a computer method was developed to calculate and plot these changes. Several commercial scale-prevention additives were tested. Some appeared to actually accelerate the deterioration of the heat transfer coefficient. Two of the additives may be of value and further tests should be made. Turbulence creators increased the heat transfer rate as predicted but they did not prevent scale. Tests are planned on a seeding process for scale prevention. Preliminary tests were made on protective coatings for steel. The more promising materials will be evaluated further.
W70-04937

RECYCLE BOOSTS DESALTING EFFICIENCY,
G. E. Weismantel.
Chem. Eng., Vol. 75, No. 15, p 86-88, 1968. 1 fig.
Identifiers: *Clair Engle Plant, Brine flow, Brine system designs, Flowsheets, Multiple effect distillation, Multistage flash distillation, System descriptions, Water costs estimate.

The process flowsheet and a brief process description are given for the Clair Engle Plant (dedicated in 1967). The plant was designed and built by Aqua-Chem for the OSW. It is a multistage multieffect facility with 3 effects and 68 stages. The first 2 effects have 23 stages each and the last has 22. Brine recirculation and long-tube design are major reasons for the high efficiency of the plant. The flow sheet indicates a product rate of 1 MGD operating at a maximum temperature of 250 deg F or 1.25 MGD at 290 deg F. OSW has not released a product cost figure, but it should be around 60 cents/1000 gal. New feedwater treatment facilities could reduce this by as much as 25%.
W70-04938

CONCEPTUAL DESIGN STUDY OF A 1-BGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW,
Oak Ridge National Lab., Tenn.
S. J. Senatore, and J. A. Smith.
ORNL-4201, Oct., 1968. 90 p, 21 fig, 4 ref.
Identifiers: *Multistage flash distillation, Conceptual designs, Concrete construction, Construction costs, Cost breakdowns, Deaerators, Flash chambers, Horizontal tube condensers, Instrumentation, Multilevel plants, Structural designs, Water costs estimate, 250 plus MGD plant.

The report presents the findings and conclusions of a conceptual design study of a 1-BGD MSF desalination plant for a hypothetical gulf of California location in 1975-1980. The desalting plant is coupled to two 5000-MWT boiling-water reactors through a backpressure turbine. The design uses a two-level brine recycle system with fifty flash evaporator stages, a flashing brine temperature

range of 250 degree F to 102.5 degree F, and a product water discharge temperature of 90 degree F. The evaporator shell is constructed of steel in the stages where the temperature is above 200 deg F and of steel-lined concrete below 200 deg F. The evaporator tubing is 90/10 copper-nickel with 0.035-in.-thick wall in the heat recovery section and 0.049-in.-thick wall in the heat reject section. The long-tube concept is used with two tube bundles of approximately 240 ft each in the heat recovery section. A two-stage spray deaerator and conventional sulfuric acid treatment is used for the makeup seawater. The total plant capital cost is $462,799,300 or $0.463 per daily gallon of capacity. Product water cost is estimated to be $0.169/1000 gallons.
W70-04939

ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
Research Triangel Inst., Durham, N. C.
J. C. Orcutt, F. G. Mixon, and D. R. Whitaker.
OSW R and D Progress Report No. 198, Nov 1966. 61 p, 11 fig, 36 ref.
Identifiers: *Direct contact heat exchange, *Heat transfer, Brine heaters, Component designs, Computerized designs, Experimental data, Feedwater heating, Fluid flow, Heat exchangers, Thermodynamics, Vapor reheat processes.

An experiment to determine the effect of oil and water mixing on heat transfer efficiency is described. It is shown that the resistance to heat flow to individual oil droplets contributes a negligible component to the overall resistance in comparison to the large decrease in the effective thermal driving force caused by fluid mixing. A quantitative relationship between the apparent and effective number of heat transfer units is presented to illustrate the effect of mixing as represented by the peclet number for the tower. A formula to calculate the peclet number is derived from the experimental data and is recommended for use in designing spray towers of large diameters. The procedure for using mixing parameters in spray tower heat exchangers is described. The vapor reheat distillation process with liquid-liquid heat exchange has been simulated mathematically and incorporated into a computer procedure which determines the best design-operation policy for a given process configuration. This procedure should be of value in planning development work, as effects of new technology can be readily studied. The 1956 OSW cost procedure is used.
W70-04940

CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
Oak Ridge National Lab., Tenn.
E. C. Hise, and S. A. Thompson.
OSW R and D Progress Report, No. 391, Aug., 1968. 200 p, 54 fig, 39 ref.
Identifiers: *Conceptual designs, *Multistage flash distillation, *Vertical tube evaporators, Capitalized costs, Component designs, Design, Design criteria, Flowsheets, Layout, Specifications, System descriptions, Water costs estimate, 51-250 MGD plant.

The conceptual design of a 250-MGD desalting plant combining a multistage flash feed heater with vertical evaporator effects in which tubes with fluted surfaces are used to obtain heat transfer performances significantly higher than those usually obtained with smooth tubes. The plant is contained in two trapezoidal reinforced-concrete structures, each housing two independent trains. The 15 vertical-tube effects are located above the 50 MSF stages. The vertical tubes condense 83% of the product water for the total plant output- the horizontal feed-heater-condenser tubes condense the other 17%. The overall plant performance ratio is 13. The estimated capital cost for the plant is 30 cents per daily gallon, and the estimated product cost is 12.9 cents/1000 gal. These costs are on a 1965 basis and apply to a follow-on plant - that is, it is assumed that a prototype plant had been built earlier. A cost review of the design by the Bechtel Corp., for a prototype plant and in 1967 dollars, indicated a capital cost of 38.3 cents per daily gal.
W70-04941

OPERATING EXPERIENCES AT THE OSW COAST TEST FACILITY, WRIGHTSVILLE BEACH, NORTH CAROLINA,
W. L. Barnes, and W. J. Hahn.
Water Production Using Nuclear Energy, Proc. AM. Nucl. Soc. Symp., Mar., 1966, Tucson, (Ed. by R G Post and R L Seale), P. 161-74, 1 fig, 4 ref, Univ. Arizona, Press, Tucson (1966).
Identifiers: *Pilot plant operations, *Wrightsville Beach plant, Chemical by-products, Chemical corrosion control, Distillation processes, Feedwater treatment, Fertilizer, Flash evaporation, Freeze processes, Hydrate processes, Multistage flash distillation, pH adjustment, Scale prevention, Seeding processes, 0-50 MGD plant.

A summary of test results on the following equipment, (1) a plant containing 2 effects of a proposed multi-effect evaporator, the first effect containing tubes with a fluted surface on the condensate side and a plane surface on the seawater side, and the second effect with double fluted tubes, (2) an LTV plant to work on the seeding techniques for prevention of calcium sulfate scale at elevated evaporating temperatures, (3) a 6-stage flash distillation plant for scale control tests using seeding techniques, (4) a 10,000-GPD seawater descaling plant designed to remove essentially all calcium and magnesium from the incoming seawater while producing a fertilizer by-product, (5) a 3000-GPD horizontal spray film evaporator, (6) a falling film evaporator to determine the effects of feedwater pH and oxygen content on the corrosion of mild steel tubes, (7) a 15,000-GPD plant and a 200,000-GPD plant featuring controlled crystallization in a butane freeze desalination process with direct contact heat exchange, (8) a plant based on a hydrate conversion process, (9) a vapor compression vacuum-freezing desalination process plant, and (10) a plant based on a hydrate desalination process using freon-12 as both a refrigerant and the hydrating agent.
W70-04942

THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
Syracuse Univ., N.Y.
S. Itahara, and L. I. Stiel.
Desalination, Vol. 4, p248-57, 1968. 3 fig, 3 ref.
Identifiers: *Computerized designs, *Mathematical models, *Programs (Computers), *Systems engineering, Distillation processes, Economic evaluations, Evaporator-condenser system designs, Evaporators, Flash evaporation, Heat balance, Material balance, Multistage flash distillation.

A method employing dynamic programming is described which adjusts the brine temperature decrement of each stage in a multistage flash evaporator to achieve minimum annual operating costs. The discussion employs an elementary evaporator model for which analytical solutions are available. A flow chart of a possible computer code is given. The evaporator area cost for an infinite number of stages if formulated. Finally, a method for handling the heat reject section is shown in mathematical notation.
W70-04943

CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
Weir Westgarth Ltd., London (England).

OSW R and D Progress Report No. 271, 1967. 97 p, 23 fig, 6 tab, 14 ref.
Identifiers: *Component testing, *Design data, *Entrainment, *Flash chambers, *Flash evaporation, Experimental data, Flow control, Liquid level control, Multistage flash distillation, Open channel flow, Research results.

An earlier study of the flash chamber geometry in multistage evaporators has shown that the length of flash chambers required for a range of flashing conditions could be specified (OSW R and D 108). This report describes additional work which has been carried out to study the separator characteristics and separation geometry in a flash chamber. The first part of this report covers a study of the foam heights and entrainment heights for a range of the flashing conditions normally met with in evaporators. The second part covers a study of the pressure loss and de-entrainment characteristics of the separator mesh. This information should allow the separator height to be specified for a range of flashing conditions and indicate the maximum value of vapor loading to which the separator can be taken while still giving a reasonable vapor purity above the separator. Further information is given on the effects of brine circulation, interstate temperature difference, splash plant configuration, and brine level variations. The increase in vapor loadings which can be obtained by dosing with an antifoam solution is indicated.
W70-04944

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
S. I. Golub, I. L. Sergeenko, E. A. Sobolev, V. B. Chernozubov, and V. G. Shatsillo.
Desalination Vol 5, p 29-33, 1968. 5 fig. Preprint from 2d European Symp.-Fresh Water From The Sea, Vol 4, Athens, May, 1967.
Identifiers: *Multiple effect distillation, *Multistage flash distillation, *Parametric studies, Acid stabilization processes, Construction costs, Economic evaluations, Evaporators, Feedwater treatment, Flash chambers, Flash evaporation, Flowsheets, Scale prevention, Seeding process.

A comparison of multieffect flash and multistage evaporation plants to determine which is the more economically advantageous indicated that the price of product water is approximately the same for each under the same operating conditions and with fixed heat costs. Two main flowsheets were used as the basis for comparison (1) flash evaporation with seawater recycle and scale prevention by seeding or acid treatment and (2) direct-flow evaporation with seeding. Product water price for both types of plants proved to be 7 to 12% lower with evaporation chambers of concrete than with metal, and scale prevention by seeding proved less expensive than that by acid treatment of feedwater. Flash evaporation plants are preferable economically in case of high heat costs, whereas the multistage evaporation plant is economically advantageous when heat costs are relatively low.
W70-04947

THE EILAT 1,000,000 GPD, MSF, DISTILLATION PLANT OPERATING EXPERIENCE,
N. Zuckerman.
Preprint from 2d European Symp.-Fresh Water From The Sea, Vol 2, Athens, May, 1967. 28 p, 9 fig, 8 ref.
Identifiers: *Flash evaporation, *Multistage flash distillation, *Operating experience, Corrosion, Corrosion control, Corrosion problems, Distillation processes, Fouling, Israel, pH control, Scale prevention, 0-5C MGD Plant.

A brief history of the Eilat Plant, which began operation in 1965 and is presently delivering about 1 MGD of fresh water continuously at 1-3 PPM TOS. The evaporator is MSF recirculating cross-tube type designed for 200 deg F top brine temperature, performance ratio 8 to 1, concentration factor 1.7, with scale prevention originally by Hagevap LP treatment but later converted to PH control. The influence of controlled parameters

and of additives on fouling, foaming, corrosion, performance ratio and distillate output is described, analyzed and discussed. Actual performance is compared to results of a mathematical model programmed for a digital computer. High temperature tests are described, and the importance of matching conditions to chamber geometry is discussed.
W70-04948

CORROSION OF MILD STEEL UNDER OPERATING CONDITIONS OF A DISTILLATION DESALTING PLANT.
For primary bibliographic entry see Field 08G.
W70-04949

DESIGN, OPERATION, AND RESULTS OF THE LARGEST FLASH-TYPE SEAWATER CONVERSION PLANT AND ITS EFFECT ON FUTURE CONVERSION PLANTS.
Westinghouse Electric Corp., Philadelphia, Pa.

Proc. Am. Power Conf, Vol 24, p 751-59, 1962. 6 fig.
Identifiers: *Dual-purpose plant, *Flash evaporation, *Reviews, Point Loma Plant, Water costs estimate, Water utilization.

Current U.S. water usage is running at the rate of about 323 BGD. By 1975 it will be 453 BGD, and by 1980 it will be 597 BGD, which is 82 BGD more than the estimated supply. Desalination of sea and brackish water can meet this shortage. To date about 50 land-based flash evaporators have been purchased throughout the world, including a 1 MGD unit at Point Loma, Calif. Design work and data taken since the inception of this plant show that flash distillation on a larger scale can produce water at a cost low enough to compete with conventional supplies in many areas. Further economies can be obtained with dual-purpose plants so that water can be produced for 41 cents/1000 gal. The design and construction of dual-purpose plants will meet the water needs, base-load power systems, develop the service areas, and may result in new low costs for power generating facilities.
W70-04950

STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART 1, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
Oak Ridge National Lab., Tenn.; and Bechtel Corp., San Francisco, Calif.
S. J. Senatore, and J. A. Smith.
ORNL-4214, Nov., 1968. 257 p, 56 fig, 3 ref.
Identifiers: *Conceptual designs, *Multilevel plants, *Multistage flash distillation, Concrete construction, Construction costs, Cost breakdowns, Deaerators, Flash chambers, Horizontal tube condensers, Instrumentation, Structural designs, 250 plus MGD plant.

The report presents the findings and conclusions of a conceptual design study of a 250-MGD MSF desalination plant for a hypothetical Southern California location in 1975-1980. The plant is coupled to a 2500-MWT boiling-water reactor through a backpressure turbine. The design uses a two-level brine recycle system with fifty stages, a flashing brine temperature range of 250 deg F to 91.8 deg F and a product water temperature of 90 deg F. The evaporator shell is steel above and steel-lined concrete below 200 deg F. The evaporator tubing is 90/10 copper-nickel with 0.035-in.-thick wall in the heat recovery section and 0.049-in.-thick wall in the heat reject section. The long-tube concept is used with two tube lengths of approximately 240 ft each in the heat recovery section. A two-stage spray deaerator and conventional sulfuric acid treatment is used for the makeup seawater. The total plant capital cost is $149,725,000 or $0.5999 per daily gallon of capacity. The water cost is $0.205/1000 gal.
W70-04951

OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
Stearns-Roger Corp., Denver, Colo.
R. W. Akerlow.
Water Production Using Nuclear Energy, Proc. Am. Nucl. Soc. Symp., Mar., 1966, Tucson (ed. by R. G. Post, R. L. Sealf), p. 112-33, 3 fig, 10 ref, Univ. Arizona, Press, Tucson, Ariz, 1966.
Identifiers: *Freeport plant, *Operating experience, *Vertical tube evaporators, Acid stabilization processes, Component development, Deaerators, Feedwater treatment, pH adjustment, Scale prevention, Scale removal.

This plant has been in operation since 1961. Studies have led to the elimination of scaling, better utilization of heat transfer surfaces, and improvement in the distributed flow conditions in the tubes. Magnesium hydroxide seeding proved impractical to prevent scaling, but the pH method of scale control was shown to be effective. Carbon steel tubing was not practical, particularly since acid addition was needed for scale control. The steel tube was replaced with aluminum-brass. It was found that, without forming anhydrite scale, the upper limit of seawater flashing range is 27 deg F on the steam side. Polyphosphate addition was very effective as a means of scale removal. Magnesium anodes were unsuccessful in the protection of steel heat exchangers. However, an impressed current protection system appeared promising. Waste heat sources at temperature levels as low as 140 deg F can be considered practical for recovery in an LTV system. Under normal conditions, one MGD of water can be economically produced from seawater in an LTV system for each 7500 KW of generating capacity, utilizing only the waste heat from a gas turbine.
W70-04952

CONTINUOUS COUNTER-CURRENT ION EXCHANGE REMOVAL OF CALCIUM FROM SEA WATER TO PREVENT SCALING OF DISTILLATION EQUIPMENT.
Oak Ridge National Lab., Tenn.; and Chemical Separations Corp., Oak Ridge, Tenn.

OSW, R and D Progress Report No. 309, Nov., 1967. 69 p, 27 fig, 3 ref.
Identifiers: *Feedwater treatment, *Ion exchangers, *Scale prevention, Material balance, Precipitates, Removal from feedwater, Calcium, Carbonate, Scaling.

A 65% removal of calcium from seawater was demonstrated by chem-seps continuous countercurrent ion exchanger at Freeport, Texas, LTV Plant. Calcium hardness as calcium carbonate was reduced from 800 PPM to 280 PPM in the effluent from exchanger. Removal of 65% calcium prevents precipitation of anhydrites at 300 deg F. This results in heat savings of 20% and a permissible concentration factor of five rather than three. Flowsheets and theoretical material balances are included.
W70-04953

TESTS OF DEAERATOR AT THE FREEPORT SEAWATER DESALTING PLANT AND EVALUATION OF DISSOLVED GAS ANALYSIS.
Oak Ridge National Lab., Tenn.

OSW R and D Progress Report No. 310, Nov., 1967. 44 p, 11 fig, 9 ref. Also ORNL-TM-1953.
Identifiers: *Carbon dioxide analysis, *Deaerators, *Oxygen analysis, Columns (Process), Component development, Component specifications, Freeport Plant.

Tests made on the Freeport deaerator showed that oxygen could be reduced to 10 PPB and carbon dioxide to 3 PPM. Test runs were made with liquid rates of 10,600 and 17,000 LB/HR sq ft. Cambridge instrument gas analyzer was used for detection of oxygen and carbon dioxide. Further work is required to check the validity of the calibrator before reading can be considered reliable.
W70-04954

OPTIMUM BRINE HEATER OUTLET TEMPERATURE IN SEA WATER CONVERSION EVAPORATORS.
Bechtel Corp., San Francisco, Calif.

OSW R and D Progress Report No. 175, Apr., 1966. 160 p, 34 fig, 17 ref.
Identifiers: *Brine heaters, *Feedwater heating, Brine system designs, Computerized designs, Cost breakdowns, Economic evaluations, Energy costs, Evaporator system design, Flash evaporation, Ground rules, Multistage flash distillation, Parametric studies, Plant layout, Water costs estimate.

Large size nuclear power and water desalting plants may answer the future needs of an expanding civilization for power and water, but the more immediate problem of providing incremental water supplies up to 50 MGD where no power is needed is unanswered. A single-purpose fossil-fueled desalination plant with a capacity from 8 to 50 MGD has been developed. A modification of this plant with acid pretreatment and operating at 290 deg F maximum brine temperature will produce 50 MGD of water at 30 cents/1000 gal with fuel at 20 cents/MBTU, or produce water at 36 cents/1000 gal with 30 cents/MBTU fuel. If scale control methods costing no more than acid pretreatment can be developed, permitting the plant to operate at its optimum temperature of 350 deg F, then water costs drop to 28.2 cents/1000 gal and 33 cents/1000 gal, respectively. Total water costs have been developed for brine heater outlet temperatures from 250 deg F to 400 deg F, for fuel costs of 20, 30 and 40 cents/MBTU. From these, costs affordable for scale prevention at the different temperatures and fuel costs have been determined. Two ORNL and one Bechtel evaporator design computer codes were modified and used for the study.
W70-04955

A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
Atomic Energy Establishment, Winfrith (England).
R. I. Hawes, and D. C. Leslie.
Desalination Vol 2, p 329-36, 1967. 7 fig, 5 ref. Also preprint from 2nd European Symp.-Fresh Water From The Sea, Vol 2, Athens, May, 1967.
Identifiers: *Bubble dynamics, *Flash chambers, *Flow distribution, Flash evaporation, Fluid dynamics, Orifices, Pressure drop, Research results, Steam flow, Turbulence, Turbulent flow.

A new theory of flashing flow is described which assumes that all bubble nuclei are present when the pressure is reduced. Steam formation occurs by conduction of heat to the surfaces of these nuclei, followed by evaporation at the surface. As the bubbles grow, the two-phase mixture is accelerated in the duct, producing a pressure drop and a further increase in the superheat. An experimental study suggests that when the superheat is small, nucleation of bubbles does not occur within the bulk of the fluid and that steam formation only occurs at existing interfaces. In a desalination plant, growth of bubbles swept from one stage to the next or flashing at the free surface is likely to be most important. Measurements of the growth of steam bubbles in superheated seawater show good agreement with the theoretical predictions during the initial stages but the theory underestimates the growth rate further away from the change in pressure.
W70-04956

THE OPTIMAL DESIGN OF DESALINATION SYSTEMS.
Kansas State Univ., Manhattan.

Desalination Vol 3, p 225-36, 1967. 14 fig, 17 ref. Also preprint from 2d European Symp.-Fresh Water From The Sea, Vol 4, Athens, May, 1967.

Identifiers: *Economic evaluations, *Design, Membrane processes, *Multiple effect distillation, Multistage flash distillation, Osmosis, Water costs estimate.

Process analysis and optimization studies have been made for a multi-effect multistage flash distillation system and a multistage reverse osmosis system. In the distillation system, the heat supplied to the brine heater, the brine reject concentration, the recirculation rates within each effect, and the allocation of brine temperature and composition among the effects are controlled to arrive at an optimal policy. In the reverse osmosis process, multistage operation is compared with single-stage operation. The recirculation rates in each stage, the allocation of brine composition among the stages and the operating pressures in each stage are controlled to arrive at the optimal operating condition. A flow-work exchanger is incorporated into the reverse osmosis system and its quantitative advantages are examined under optimal conditions. A discrete form of the maximum principle in combination with other optimization techniques has been used for most of the optimization studies.
W70-04957

THE FLOW OF FLASHING WATER IN CONDUITS.
Heriot-Watt Univ., Edinburgh (Scotland); and Glasgow Univ., (Scottland).

Desalination Vol 2, p 175-95, 1967. 15 fig, 7 ref. Also preprint from 2d European Symp.-Fresh Water From The Sea, Vol. 4, Athens, May, 1967.
Identifiers: *Entrainment, *Flash evaporation, *Steam flow, *Vapor release rate, Distillation processes, Evaporators, Flow distribution, Horizontal tube evaporators, Multistage flash distillation, Turbulence promoters, Vapor compression evaporation, Vertical tube evaporators.

An analysis of flashing flow is presented in which the local rate of vapor formation is introduced, since its finite value determines the nonequilibrium character or flashing flow. A simple theoretical model is developed for calculation of the rate of vapor formation equations are set forth to describe flashing flow, and analytical solutions are presented for the simple frictionless flow case. For the more general problem including friction effects, numerical solutions are given. Experimental work on flashing flow in both horizontal and vertical tubes of 1-in. diameter show good agreement over a range of friction factors of 0.113 to 0.805 reciprocal feet. Turbulence promoters were introduced into the test sections to increase the equilibration, and their effects are reported. Experiments using two-component air-water mixtures made to check the slip between the phases and to determine the two-phase friction factors are reported.
W70-04958

PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
Applied Research and Engineering Ltd., Durham (England); and International Combustion Export Ltd., London (England).
R. Starmer, F. C. Thornley, and J. A. Modet.
Desalination Vol. 3, p 343-52, 1967. 8 fig, 5 ref. Also preprint from 2d European Symp.-Fresh Water From The Sea, Vol 2, Athens, May, 1967.

Descriptors: *Flash Evaporation, *Tube bundle design, *Tubing (Metal), Distillation processes, Economic evaluations, Flow measurement, Heat transfer coefficient, Heat transfer improvements, Heat transfer surfaces, 51-250 MGD Plant.

The economics and technical problems of desalination plants as large as 100 MGD are evaluated with respect to tube positions, possibilities of reducing vessel width, method of fitting total tube area, and importance of water flow problems. It is shown that for evaporator modules of over 5 MGD, tubes lying in the longitudinal axis are more compatible with requirements of tube length/stage and of shallow tube bundles. Potential cost advantages of reducing vessel width are counterbalanced by increases in brine flow rates, vessel length, tube diameter, orifice, and stage height as well as difficulties in obtaining full flashoff. It is considered that brine flow rates should not exceed 1 million LBS/HR ft width. A study of fitting the total tube area indicates that tubes of 3/4 to 1-inch diameter and of the longest possible lengths are best, but practical aspects of transport and handling must be considered. Economic advantages to be achieved in increasing module size are relatively small because tubing cost is already of such magnitude that further size increase gives little advantage. Any appreciable advantage must result from cost reductions in the evaporator shell, pumps, other auxiliaries, instrumentation, foundation, land costs and erection work.
W70-04959

3B. Water Yield Improvement

ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
National Center for Atmospheric Research, Boulder, Colo.
For primary bibliographic entry see Field 02B.
W70-04756

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
State Inst. of Hydrology and Meteorology, Krakow (Poland).
For primary bibliographic entry see Field 04A.
W70-04759

EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
Washington Univ., Seattle. Coll. of Forest Resources.
David D. Wooldridge.
Available from the Clearinghouse as PB-190 324, $3.00 in paper copy, $0.65 in microfiche. Completion Report, University of Washington, Seattle, January 1970. 16 p., 6 fig, 5 ref. OWRR Project A-027-WASH.

Descriptors: *Analog models, *Forest management, *Infiltration, Water yield, Watershed management, *Precipitation intensity, Hydrologic models, Rainfall-runoff relationship, Computer models.

Review of a wide variety of hydrologic modeling procedures resulting in a conclusion that the methods of Riley, et al. (1966) were most suitable for general forest hydrology needs. A function generator is used to generate any type of a precipitation event. This precipitation event becomes an input into a series of storage and flow equations. Infiltration as a flow process described by the equation of Horton (1940) is analyzed in detail for influences of various input parameters. Solution of this type of problem is a good example of the utility of electric analogy in the solution of hydrologic problems. Continuous solutions over time may be visually displayed and the influence of changing coefficients studied quantitatively after correct initial scaling. Related aspects of this research are continuing.
W70-04854

THE RANGELANDS OF THE WESTERN U.S.,
California Univ., Davis. Dept. of Agronomy.
R. Merton Love.
Scientific American, Vol 222, No 2, p 88-96, February 1970.

Descriptors: *Range management, *Brush control, *Water yield improvement, *Pasture management, Cattle, Ranges, Grasslands, Grazing, Southwest U.S., Recreation demand, Revegetation, Multiple purpose, Rocky Mountain region, Desert plants.
Identifiers: *Western U.S., *Vegetation manipulation.

Cattle grazing is the primary use of the rangelands in the western United States. The western ranges fall into three distinct categories: Northern Rocky Mountain; Intermountain, and Southwest. True grassland is rare in the Southwest. Instead, deserts and semi-deserts predominate. Vegetation management is the major problem in improving the rangelands. Brush conversion programs have shown substantial increases in water yield in the treated areas. This is due to the fact that an acre of brush uses six more acre-inches of water than does herbaceous vegetation. (Carr-Arizona)
W70-04907

THE WATER SITUATION,
Arizona State Water Engineer; and Arizona Interstate Stream Commission.
Wesley E. Steiner.
In Arizona Watershed Symposium, 13th, Phoenix, Arizona, September 24, 1969, Proceedings, p 11-14.

Descriptors: *Arizona, *Planning, *Water supply, *Water resources, *Water allocation (Policy), Arid lands, Groundwater, Overdraft, Urbanization, Population, Growth rates, Land use, Irrigation, Water resources development, Subsidence, Decision making, Optimum development plans, Water demand, Water yield improvement.
Identifiers: *C.A.P. (Central Arizona Project), *Arizona Interstate Stream Commission.

Arizona, an arid state, is experiencing an enormous rate of growth. Without an adequate water supply this growth will be severely limited. Even though urban land uses are expected to take over much of the presently irrigated agricultural acreage, current federal and state studies project an increase in total irrigated acreage in the future. The central Arizona area already has a groundwater overdraft of 2.2 MAF per year. Operation of the Central Arizona Project will still leave central Arizona with a 1 MAF annual overdraft. Although CAP will not totally relieve Arizona's water problems, it will buy time for the state until other plans can be developed. Planning for future projects should begin immediately. (Carr-Arizona)
W70-04914

FOG IN ISRAEL,
Israel Meteorological Service, Bet Dagan. Div. of Synoptic Meteorology.
M. Levi.
Israel Journal of Earth-Sciences, Vol 16, No 1, p 7-21, 1967. 10 fig, 2 tab, 6 ref.

Descriptors: *Fog, *Moisture, *Semi-arid climates, *Winds, Anticyclones, Transportation, Agriculture, Meteorology, Fronts (Atmospheric), Air circulation, Water vapor, Atmospheric pressure, Synoptic analysis, Radiation.
Identifiers: *Radiation fog, *Israel, Inversions, Sudan Trough, Khamsin depression.

Generally only radiational fog occurs in Israel. True advection fog is very rare. Typical fog-inducing meteorological situations include a warm upper anticyclone, a shallow surface pressure ridge in the wake of a cold front, influence of the Sudan Trough, an approaching Khamsin depression, and the passing of a weak, dissolving cold front. Fog occurs infrequently on the Israeli coastal plain, but is more common in the northern valleys of Israel and in parts of the Northern Negev. Fog is not a major problem in Israel, but it does occasionally tie up the transportation process. Fog is also important in the semi-arid Israeli climate as a source of additional moisture supply for agriculture. (Carr-Arizona)
W70-04915

MANIPULATING VEGETATION FOR WATER CONSERVATION,
Salt River Valley Water Users' Association, Phoenix, Ariz.

William L. Warskow, Robert E. Moore, and David S. Wilson, Jr.
Agricultural Engineering, Vol 50, No 1, p 24-25, January 1969. 2 tab.

Descriptors: *Range management, *Runoff, *Water conservation, *Water yield improvement, *Brush control, Juniper trees, Chaparral, Forest management, Lumbering, Clear-cutting, Arizona, Arid lands, Grasses.
Identifiers: *Vegetation manipulation, Salt River Valley Water Users' Association.

Vegetation manipulation is an immediate and direct method of augmenting water supplies through increasing runoff. In Arizona experiments are in progress which study the water gain from juniper eradication, chaparral conversion, and timber harvest techniques. The Salt River Valley Water Users' Association is funding these studies in conjuction with the U.S. Forest Service. (Carr-Arizona)
W70-04916

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
Arizona Conservation Council.
Paul W. Van Cleve.
In Arizona Watershed Symposium, 13th, Phoenix, Arizona, September 24, 1969, Proceedings, p 25-28.

Descriptors: *Arizona, *Natural resources, *Water resources development, *Conservation, *Water yield improvement, Recreation demand, Scenery, Wildlife, Habitats, Phreatophytes, Chaparral, Brush control, Flood control, Aesthetics, Water management (Applied).
Identifiers: *Salt River Project, *Bureau of Reclamation, *U.S. Army Corps of Engineers, Wilderness.

One of Arizona's most valuable natural resources is its reputation for scenic beauty. This natural beauty is a very vulnerable resource that is presently under tremendous pressure by forces of growth. The Salt River Project opposes two proposed wilderness areas in Arizona in favor of a very high-cost, low-yield chaparral treatment program. The U.S. Army Corps of Engineers is singularly unimaginative in its Maricopa County food control project designs. The interagency phreatophyte control program also gives little consideration to recreation, scenic beauty, and wildlife habitat in streamside areas. Conservation organizations recognize the critical need for water yield improvement projects. Care must be taken in the development of such water yield and flood control programs not to sacrifice esthetic values unnecessarily. (Carr-Arizona)
W70-04917

3C. Use of Water of Impaired Quality

IRRIGATING VEGETABLES WITH BRACKISH WATER,
Agricultural Research Service, Athens, Ga. Soil and Water Conservation Research Div.; and Georgia Agricultural Experiment Station, Athens.
F. L. Long, J. M. Daniels, and J. R. Carreker.
American Society of Agricultural Engineers, Transactions, Vol 11, No 2, p 171-174, March-April 1968. 4 fig, 3 tab, 5 ref.

Descriptors: *Vegetable crops, *Irrigation water, *Brackish water, *Saline water, *Salt tolerance, Salinity, Irrigation practices, Irrigation, Georgia, Plant physiology, Leaching, Soil properties, Electrical conductance, Saturated soils, Rainfall, Crop production.
Identifiers: *Turnips, *Kale, *Collards, *Snapbeans.

Irrigation with saline water adds salts to the upper level of the soil. This may cause a salt problem in soils ordinarily considered nonsaline. In determining whether or not to use a particular brackish water supply for irrigation it must be remembered that some crops are more salt-sensitive than others. Also, plants in the seedling stage are generally more susceptible to salt damage than mature plants. A 3-year experiment studied the use of brackish vs. salt-free water in the irrigation of kale, collards, turnips, and snapbeans. The results showed that saline irrigation had no significant effect on the yield of kale, collards, and turnips, but lowered the yield of snapbeans considerably. The study also showed that rainfall was very effective in leaching the applied salts from the plots. These results have positive implications for irrigation of crops with saline water in the arid Southwest. (Carr-Arizona)
W70-04906

A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
North Dakota State Univ., Fargo. Dept. of Soils.
Fred W. Schroer.
Available from the Clearinghouse as PB-190 357, $3.00 in paper copy, $0.65 in microfiche. Technical Completion Report, North Dakota Water Resources Research Institute, February 1970. 48 p, 7 tab, 13 fig, 9 ref, append. OWRR Project A-005-NDAK.

Descriptors: *Irrigation water, Soils, *Saline soils, Saline water, *Soil physical properties, *Soil chemical properties, Carbonates, Sulfates, Loams.
Identifiers: Soil salinity.

The experiments were conducted by the North Dakota Agricultural Experiment Station in the greenhouse, and at four sites in irrigated fields. Eight by 21 inch columns of Heimdal (Typic Haploboroll) loam were seeded with alfalfa and irrigated for 20 months with 18 synthetic waters and distilled water. The waters represented groundwaters and streams of North Dakota. They ranged in salinity and sodium hazard from C2S1 to C4S4 (US Salinity Lab. Classification). Anions were HCO3 and SO4. One series had excess HCO3 over Ca plus Mg. Treatments were replicated five times. About 145 inches of water was applied in 79 irrigations to produce 24 cuttings of alfalfa. Carbonates precipitated in the lower half of columns with C2 waters. Both SO4 and CO3 salts precipitated in soils with C3 and C4 waters. ESP of soils increased with increasing SAR of the waters applied. Excess HCO3 increased soil ESP, caused ESP maxima near the soil surface, and greatly decreased infiltration rates compared to waters of similar salinity and SAR without excess HCO3 . Increasing SAR caused lower infiltration rates, but increasing salinity opposed this trend. Chemical analyses of four field irrigated soils were compared with similar data obtained prior to or near the initiation of irrigation. The Straw loam at Dickinson was near equilibrium with C2S1 water applied by gravity for 23 years, at 18 inches per year. Salinity and ESP were lower than before.
W70-04985

3D. Conservation in Domestic and Municipal Use

UTILITIES ON PERMANENT SNOWFIELDS,
Army Terrestrial Sciences Center, Hanover, N.H.
Malcolm Mellor.
Cold Regions Research and Engineering Laboratory, Science and Engineering Monograph III-A2d, October 1969. 37 p, 23 fig, 46 ref. DA Project 1T062112A130.

Descriptors: *Water supply, *Waste disposal, *Public utilities, *Cold weather construction, *Cold regions, Polar regions, Antarctic, Arctic, Sewage disposal, Melting.
Identifiers: *Snowfields, Cold region engineering.

Water supply, waste disposal, heating, ventilating and fire protection at installations built on polar ice sheets are described. The section on water supply discusses energy requirements, consumption rates, water quality and treatment, techniques and equipment for melting snow and ice, and water distribution systems. A number of actual water supply systems are described in detail. The section on waste disposal deals with sewage and sewage sinks, latrines, garbage, trash and scrap, and radioactive waste. Examples of sanitation systems at polar bases are described in some detail. The section on heating discusses heating load, heat losses and insulation, energy sources, and heating systems. The ventilation section covers air demands, intakes and exhausts, ventilation of undersnow tunnels, and carbon monoxide problems. Fire protection is discussed briefly. (Knapp-USGS)
W70-04740

3E. Conservation in Industry

PETROLEUM INDUSTRY IN ILLINOIS, 1968: PART 2. WATERFLOOD OPERATIONS,
Illinois State Geological Survey, Urbana.
For primary bibliographic entry see Field 06D.
W70-04737

3F. Conservation in Agriculture

IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
Texas Tech Univ., Lubbock.
Dan M. Wells.
Pap, Amer Soc Civ Eng Irrig Drain Div Conf, Austin, Tex, Nov, 1969. 16 p, 4 tab, 5 ref.

Descriptors: *Irrigation, *Value, *Economic impact, *Texas, Economics, Agriculture, *Economic justification, Crop production, Crops, Irrigated land, Economics, *Benefits, Agronomic crops, Farm prices, Water costs.
Identifiers: *Texas Water Plan, High Plains (USA), Ogallala formation, Agricultural economics.

Without the Texas Water Plan, or a similar plan for importing water to the High Plains of West Texas, irrigated agriculture there will start a decline that will end in oblivion in less than a century. The secondary and tertiary benefits to irrigation in the High Plains far outweigh the primary benfits. The value of irrigation in areal economy cannot be estimated on the basis of the value to farm operators alone; merchants, suppliers, processors of agricultural products, bankers, and the general population depend upon the output from irrigated agriculture to supply the capital and operating expenses for maintaining the economy. If imported water is not made available to replace the declining supplies available from the Ogallala, agriculture will not collapse, but agriculture-based businesses will feel the backlash of a decline in agricultural production. The nonagricultural segment of the High Plains should be willing to subsidize the importation of water required to sustain the present level of irrigated agriculture. Neither the State of Texas nor the Nation can afford to lose the production and consumption associated with the present and projected levels of High Plains irrigated agriculture. (USBR)
W70-04618

MECHANICAL STRUCTURES FOR FARM IRRIGATION,
Agricultural Research Service, Kimberly, Idaho. Snake River Conservation Research Center.
Alan S. Humpherys.
Proc Amer Soc Civ Eng, J Irrig Drain Div, Vol 95, No IR4, p 463-479, Dec 1969. 17 p, 17 fig, 2 tab, 3 ref, 3 append.

Descriptors: *Automation, *Irrigation systems, *Automatic control, *Control structures, *Hydraulic gates, Irrigation, Irrigation practices, Irrigation

engineering, Turnouts, Mechanization, Water control, Movable dams, Water distribution (Applied), Timing, Farm equipment, Control systems, Check structures, Check dams, Furrow irrigation.

Mechanical, automatic irrigation structures that can save water and labor are being developed for surface irrigation systems. The timer-controlled and automatic water-pressure-controlled structures are being tested in various types of irrigation systems. A specially designed mechanical timer is used to control semiautomatic irrigation checks and gates. Generalized design information is presented for a timer-controlled check dam for lined and unlined ditches. A pressure gate that opens and closes automatically when water in the channel approaches a certain depth is described. Other structures include a drop gate, metal apron gate, and water level control checks. Certain operational problems such as rodent and weed control require greater emphasis with automatic irrigation than with conventional systems. (USBR)
W70-04638

AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
Agricultural Research Service, Fort Collins, Colo.
Howard R. Haise, and E. Gordon Kruse.
Proc Amer Soc Civ Eng, J Irrig Drain Div, Vol 95, No IR4, p. 503-516, Dec 1969. 14 p, 13 fig, 9 ref, append.

Descriptors: *Irrigation systems, Automatic control, Automation, Water control, Control structure, Hydraulic gates, Mechanization, Check dams, Hydraulic gates and values, Butterfly valves, Surface irrigation, Furrow irrigation, Turnouts, Control systems, Water distribution (Applied), Timing, Telemetry systems, Check structures.

Surface irrigation can be automated by using pneumatic valves controlled electronically by tone telemetry to open and close turnouts on a timed basis. However, features of cost, reliability, and safety make a hydraulically powered system appear more feasible. The hydraulic system, using cylinders to operate center pivot gates, can be adapted to a variety of open-ditch systems. Hydraulic systems can be used to open or close gates or to modulate gate openings to maintain a constant water level upstream or downstream from the gate. Two systems for automating surface irrigation are described. One system uses pneumatic valves remotely controlled by tone telemetry to open and close turnouts at timed intervals; the other uses waterpowered cylinders activated by float valves to operate center pivot gates. Large fluidic diverters have also been evaluated for irrigation applications. The automation components can be adapted to furrow, border dike, and basin-irrigated fields supplied by open ditches or buried pipelines. Several field systems have been evaluated. (USBR)
W70-04639

EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
Agricultural Research Service, Riesel, Texas. Southern Plains Branch; and Texas Agricultural Experiment Station, Riesel.
Ralph W. Baird, and Clarence W. Richardson.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 69-78, University of Texas Press, Austin and London, 1969. 10 p, 4 fig, 3 tab, 2 ref.

Descriptors: *Agricultural watersheds, *Land management, *Watershed management, *Texas, Runoff, Sediment yield, Demonstration watersheds, Contour farming, Terracing, Vegetation establishment, Land forming, Erosion control.
Identifiers: Experimental watersheds.

The effects of land-use changes and conservation treatments on storm runoff from 4 small agricultural watersheds, ranging in size from 20 to 309 acres, are being studied at the Blacklands Experimental Watershed near Riesel, Texas. The soils of the watersheds are primarily Houston Black clay and closely related soils developed from marls of the Taylor formation. These soils are calcareous montmorillonite clays that shrink and swell with drying and wetting. Internal drainage is slow, and during prolonged periods of excess rainfall, free water may be held near the surface for appreciable periods of time. During extreme dry periods the soils shrink, and cracks several inches wide to depths of 3 feet or greater are common. Conservation practices that control the flow of water on cultivated fields and the use of agronomic practices that increase crop production with more residue to return to the soil may reduce storm runoff from small watersheds as much as 20 to 25% over a period of years. Because of the short period of record, the effects of changes from cultivated areas to permanent grasses used for grazing is not as well defined, but available data indicate that grazing of grasslands can be managed to increase storm runoff, with smaller amounts of sediment. (See W70-04723). (Knapp-USGS)
W70-04730

IRRIGATING VEGETABLES WITH BRACKISH WATER,
Agricultural Research Service, Athens, Ga. Soil and Water Conservation Research Div.; and Georgia Agricultural Experiment Station, Athens.
For primary bibliographic entry see Field 03C.
W70-04906

EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
Adelaide Univ. (Australia). Dept. of Botany.
Susan Barker, and R. T. Lange.
Australian Journal of Botany, Vol 17, No 3, p 527-537, December 1969. 13 fig, 4 tab, 10 ref.

Descriptors: *Stock water, *Vegetation, *Plant populations, *Stocking, Water holes, Arid lands, Ranges, Sheep, Grazing, Forage, Vegetation effects, Density, Frequency, Desert plants, Dams, Deterioration, Pasture management.
Identifiers: *Australia, *South Australia.

The investigation was concerned with description and analysis of vegetation change in arid areas subjected to many years of grazing. A hypothesis under study indicated that vegetation change would be patterned on the stocking pressure in the area. In arid lands this would imply that radial gradients would appear around water sources. Vegetation within a 2000-yd radius of a stock water dam was investigated. Stocking did not appear to have a pronounced effect on the majority of the species within the study area, however several species did demonstrate significant linear regressions between density and radial distance from the water. These observations substantiate the findings of Osborn, Wood, and Paltridge regarding stocking and vegetation gradients with respect to water. (Carr-Arizona)
W70-04911

DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Irrigation Research Lab.
For primary bibliographic entry see Field 02I.
W70-04912

SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
Idaho Univ., Moscow. Dept. of Agricultural Engineering.
G. L. Corey.
American Society of Agricultural Engineers, Transactions, Vol 12, No 6, p 795-797, November-December 1969. 6 tab, 9 ref.

Descriptors: *Farms, *Pumping, *Irrigation water, *Costs, *Economics of scale, Arid lands, Idaho, Farm management, Deep-well pumping, Groundwater, Irrigation efficiency, Water table, Variability, Variable costs, Rotations, Size, Drawdown, Cost-benefit analysis, Crop production, Unit costs, Computers.
Identifiers: *Farm size, Unit basis, Snake River Basin, (Ida).

Large areas of arid land in Idaho have been developed for irrigation over the past 15 years. This development generally has involved high-lift pumping. As the water table is lowered, irrigation will become more expensive due to pumping costs. The purpose of this study was to determine if farm size affected the amount of revenue a producer could pay for water on a unit basis. A synthetic firm approach was used and a definite pattern of decreasing costs with increasing farm size was established. Based on the model, a table is included giving maximum pumping lift utilizing the revenue available for water. (Carr-Arizona)
W70-04918

A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
For primary bibliographic entry see Field 02D.
W70-04920

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 02D.
W70-04922

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
California Univ., Riverside; and Arizona Agricultural Experiment Station, Tucson.
For primary bibliographic entry see Field 02D.
W70-04923

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
For primary bibliographic entry see Field 02D.
W70-04924

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
Texas A and M Univ., College Station. Water Resources Inst.
For primary bibliographic entry see Field 06B.
W70-04983

A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
North Dakota State Univ., Fargo. Dept. of Soils.
For primary bibliographic entry see Field 03C.
W70-04985

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on the Surface

TRANSFERRING STREAMFLOW CHARACTERISTICS,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 02E.
W70-04554

LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
Agricultural Research Service, Akron, Colo. Central Great Plains Field Station.
Rome H. Mickelson, and B. W. Greb.
Journal of Soil and Water Conservation, Vol 25, No 1, p 13-16, January-February 1970. 4 p, 3 fig, 3 tab, 6 ref.

Descriptors: *Land management, *Water conservation, *Playas, *Lake basins, *Land reclamation, *Land forming, Drainage, Watershed management, Land development, Soil management, Great Plains.
Identifiers: Lagoon leveling, Prairie potholes.

On the west-central Great Plains lie numerous irregularly shaped basins commonly referred to as lagoons, potholes, swales, or playas. These small depressions are usually 2 to 5 feet below the surrounding land and collectively comprise less than 1% of the region's total land area. They have no natural drainage outlets and intermittently become shallow ponds. Lagoon leveling converted a non- to low-productive area to a moderately productive area by providing more uniform distribution of impounded water over a larger surface area. Water supplies were adequate to permit annual cropping of forage crops in the leveled lagoon, and dry matter yields were increased 25% over those on unleveled dryland areas. A farmer can expect to recover an investment of $90 to $100 per acre in leveling costs within a period of 4 to 6 years, given normal rainfall and good management practices. (Knapp-USGS)
W70-04555

EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
Soil Conservation Service, Fort Worth, Tex. Engineering and Watershed Planning Unit.
Charlie M. Moore.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 101-117, University of Texas Press, Austin and London, 1969. 17 p, 11 fig, 1 tab, 6 ref.

Descriptors: *Flood control, *Small watersheds, *Dams, Spillways, Watershed management, Rainfall-runoff relationships, Hydrograph analysis, Computer models, Peak discharge.
Identifiers: Small flood control structures.

The effects of small flood-control structures on peak flow are described. A typical floodwater-retarding structure consists of an earth dam, a drop-inlet principal spillway, and an open-channel emergency spillway. The emergency spillway consists of an inlet channel, a control section, and an exit channel. Subcritical flow exists in the inlet channel and the flow usually is supercritical in the exit channel. Dams are of small to medium size, with embankment heights ranging generally from 20 to 60 feet. A few approach or exceed 100 feet. Their drainage areas range from less than 1 sq mi to more than 50 sq mi, but most measure from 1 to 20 sq mi. Their storage capacity may be as much as 12,500 acre-ft for floodwater detention and 25,000 acre-ft total for combined uses. The capacities of most of the structures built to date range generally from 500 to 2,000 acre-ft. A study was made on Escondido Creek, near Kenedy, Texas, where 50% of the upstream structures had been completed on the 74,880-acre project. The Escondido Report includes a detailed analysis of the August 28-29, 1946, storm. It was determined that the natural peak discharge of 22,700 cfs was reduced by the effect of SCS flood-detention reservoirs to 14,600 cfs. (See W70-04723). (Knapp-USGS)
W70-04571

MECHANICAL STRUCTURES FOR FARM IRRIGATION,
Agricultural Research Service, Kimberly, Idaho. Snake River Conservation Research Center.
For primary bibliographic entry see Field 03F.
W70-04638

AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
Agricultural Research Service, Fort Collins, Colo.
For primary bibliographic entry see Field 03F.
W70-04639

FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.
Corps of Engineers, Honolulu, Hawaii.

Corps Engineers Flood Plain Report, January 1970. 19 p, 11 fig, 7 plate.

Descriptors: *Floods, *Flood damage, Flood plains, Flood control, Non-structural alternatives, *Hawaii, Maximum probable flood, Tsunamis, Tides, Storms, Waves (Water).
Identifiers: Kihei (Hawaii), Maui (Hawaii), Standard project flood, Intermediate regional flood.

Flooding in Kihei, Maui, Hawaii is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-04713

EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
Agricultural Research Service, Riesel, Texas. Southern Plains Branch; and Texas Agricultural Experiment Station, Riesel.
For primary bibliographic entry see Field 03F.
W70-04730

FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
Corps of Engineers, Savannah, Ga.

Corps Engineers Flood Plain Report, June 1969. 34 p, 8 fig, 18 plate, 11 tab.

Descriptors: *Floods, *Flood damage, *South Carolina, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood.
Identifiers: Aiken County (S.C.), Standard project flood, Intermediate regional flood.

Flooding of Horse Creek, Aiken County, South Carolina is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-04738

STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
Mirko Melentijevich.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 656-667, 1966. 12 p, 8 fig, 7 ref.

Descriptors: *Water storage, *Reservoir operation, *Regulation, *Reservoir design, *Streamflow forecasting, Probability, Statistical methods, Inflow-outflow analysis, Hydrographs, Correlation analysis, Monte Carlo method, Stochastic processes, Markov processes.
Identifiers: Probability density function.

Reservoir design is discussed for situations in which the outflow is the same as the average inflow, the outflow is varied with the inflow, the outflow varies with the amount of water storage in the reservoir, and the outflow is varied both with the inflow and with amount of storage in the reservoir. The basic equations for each of these four cases are derived. Also the general equation for all four cases is given. The equations for probability density function of storage and for mean, variance, and skewness of the range of storage are given for the case when inflow minus outflow is a normal independent variable with zero mean and a variance of unity. The equations are given for the case of serial correlation between inflows. The effect of autocorrelation of streamflow is being investigated by the use of a Monte Carlo procedure, for streamflows which are first order Markov processes. (Knapp-USGS)
W70-04744

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
Zdenek Kos.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 668-682, 1966. 15 p, 6 fig, 14 ref.

Descriptors: *Water storage, *Reservoir design, *Reservoir yield, *Streamflow forecasting, *Irrigation water, Probability, Statistical methods, Economics, Optimization, Water requirements.
Identifiers: Czechoslovakia.

When regulating runoff by means of reservoirs it is often necessary to use the compensation draft. This method of regulation is often used especially for irrigation purposes. Under the conditions of a semi-humid climate, as is the case in the largest part of Czechoslovakia, it is necessary to consider irrigation only when the required drafts can be obtained at relatively low cost. A method for the determination of the degree of securing of the water-economy system function is based on Potapoff's graphical estimation of exceedance probabilities. The method has been considered for a number of different cases starting with the simple and proceeding to the more complex ones. The simplest of these cases is that of a system consisting of a single reservoir used for compensation draft for irrigation consumption which is considered centered in a single profile. The hydrologic relationship between the diversion site and that of the reservoir is taken to be so strongly affected by the effects of the intermediate watershed and by time of flow that the flows filling the reservoir and those in the diversion site can be regarded as independent. (Knapp-USGS)
W70-04745

THE OPERATION OF REGULATING RESERVOIRS,
Water Resource Board, Reading (England). Research Div.
V. K. Collinge, R. Fisher, and R. B. Bussell.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Associa-

tion of Scientific Hydrology, Publication No 71, p 683-695, 1966. 13 p, 6 fig, 4 ref.

Descriptors: *Reservoir operation, *Regulation, *Streamflow, Reservoirs, Reservoir storage, Reservoir yield, Streamflow forecasting, Routing, Analog models.
Identifiers: *Great Britain, Regulating reservoirs.

The development of regulating reservoirs in Britain is described, with considerations of conflicting demands on storage and the problems of operation, and with particular reference to Bala Lake, North Wales. The effect on the system of the new reservoir Llyn Celyn is discussed, and the results of different operating procedures presented. A comprehensive research program to solve the problems of river regulation is described. (Knapp-USGS)
W70-04746

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
Transdanubian water Authority, Szekesfehervar (Hungary).
Gy. Bukovszky.
English summary included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 699-706, 1966. 8 p, 8 fig, 8 ref.

Descriptors: *Reservoir design, *Flood control, *Reservoir storage, *Streamflow forecasting, Water management (Applied), Model studies, Analog models, Reservoir operation, Small watersheds, Regulation.
Identifiers: *Hungary, Flood storage reservoirs.

On the basis of the meteorological conditions existing in Hungary, storage reservoirs for flood retention are classified into reservoirs for snowmelt-flood retention and reservoirs for stormwater. Solution of the storage equation is discussed. In the case of an open spillway with vertical walls there is a linear relationship between the stored volume and spillway overflow. This relationship is akin to the Muskingum equation, and to the linear relationship established for characteristic riverbed stretches by Kalinin, but whereas the Muskingum coefficient of proportionality depends on the hydrograph, the Kalinin coefficient is determined in advance by the physical characteristics of the storage reservoir and the spillway. The linear relationship permits the use of electric analogs and in the case of a closed spillway the relationship can be linearized. (Knapp-USGS)
W70-04747

QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
Institut fuer Wasserwirtschaft, Berlin (East Germany).
S. Dyck, and M. Schramm.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 707-710, 1966. 4 p, 1 ref.

Descriptors: *Reservoir design, *Streamflow forecasting, *Statistical methods, *Probability, Water storage, Runoff forecasting, Mass curves, Queuing theory, Linear programming, Hydrologic data, Depth-area-duration analysis, Rainfall-runoff relationships.
Identifiers: *Germany.

Seasonal changes of streamflow and sequential correlations between months are considered by duration curves of monthly flows. Considering the release rule and the storage capacity, 12 separate sets of queuing equations are set up to be solved as a simultaneous system of equations. In this system the available flood control storage may change from month to month. The solution of the 12 sets of equations produces the frequency distribution of storage, the probability of spilling, and the probability of being empty for each month of the year. The total probability of guarantee of the reservoir yield follows from the probability of the 12 months, considering the rules of the probability theory. The probability routing and the simultaneous solution of all 12 months are solved by an electronic computer. (Knapp-USGS)
W70-04748

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
Toronto Univ., (Ontario). Dept. of Mechanical Engineering.
Vit Klemes.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 711-719, 1966. 9 p, 3 fig, 19 ref.

Descriptors: *Reservoir operation, *Water management (Applied), *Streamflow forecasting, *Cost-benefit analysis, *Probability, Statistical methods, Optimization, Regulation, Flood control, Reservoir design, Synthetic hydrology, Model studies, Mathematical models.
Identifiers: *Czechoslovakia.

Present methods of streamflow control calculations, both deterministic and probabilistic, determine the certainty (or the risk) of the regulated outflow from a reservoir in relation to a long, practically unlimited period of time assuming a stationary regime of regulation. As a characteristic of certainty, we obtain one numerical value which, however, does not say much about the question of prime interest, that is, about the certainty of the given draft during the period, (say, 20-30 years) since reservoir operation began. Using this long-term certainty and carrying out the cost-benefit analysis for a 100-years period, we seem to have a deep knowledge of what will happen in the far-off future. In fact, our present optimal solutions will hardly remain optimal after 20-30 years because of changes in technology, relation of prices, etc. The system which is proposed to meet its conditions of optimality after 100 years is thus not based on a realistic concept. The best methods for studying these problems are probabilistic methods of streamflow regulation, especially the methods based on simulation of synthetic flow series. However, some problems of this kind can be analyzed also by means of deterministic methods. An example shows how the certainty distribution caused by the initial filling of a reservoir can be obtained for a given chronological series, using the deterministic method. (Knapp-USGS)
W70-04749

FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
J. W. Van der Made.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 720-738, 1966. 19 p, 9 fig, 2 tab, 3 ref.

Descriptors: *Flood routing, *Flood control, *Channel improvement, Flow control, Water management (Applied), Water spreading, Channel morphology, Hydraulics, Waves (Water).
Identifiers: *Flood wave subsidence.

It is a well-known phenomenon, that, when moving downstream a flood wave on a river subsides. This subsidence is a consequence of the difference between the gradient of the water level before and behind the wave crest. The gradient before the crest is steeper than behind it, so the quantity of water discharged at the front is larger than the supply at the back. Subsidence of the wave crest is the result. This subsidence is determined by the variation of the gradient in the stream direction, and by the sharpness of the peak. For a flood wave this sharpness depends on the width in which this volume is stored. If the same quantity of water is distributed over a larger width, the length of the flood wave will decrease, and the wave crest will become more peaked. As a consequence the extent of subsidence will be larger. (Knapp-USGS)
W70-04750

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
State Inst. of Hydrology and Meteorology, Krakow (Poland).
Wlodzimierz Meyer.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 651-655, 1966. 5 p, 9 ref.

Descriptors: *Reservoir operation, *Reservoir yield, *Water storage, *Reservoir storage, *Runoff forecasting, Routing, Streamflow forecasting, Inflow, Statistical methods, Hydrographs.
Identifiers: *Poland.

An empirical formula was derived for computation of the useful capacity of retention reservoirs in Poland. Mean annual discharge for long periods, discharge variability, the mean longitudinal slope of the river valley, the amount and guarantee of runoff, and an index characterizing the variability of the yearly water input to the reservoir are used as data. The formula was derived on the basis of the cases of steady or variable annual discharge from the reservoir, assuming that the reservoir is used for water power, amelioration and inland navigation. However, the index characterizing the variability of input used in the formula is of general character, and applies also to other cases of runoff variability. A nomogram for the formula makes it easier to perform the computations in practices. (Knapp-USGS)
W70-04759

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS: MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
For primary bibliographic entry see Field 06E.
W70-04870

WATER RIGHTS IN TENNESSEE,
For primary bibliographic entry see Field 06E.
W70-04874

WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
For primary bibliographic entry see Field 06E.
W70-04875

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
For primary bibliographic entry see Field 06E.
W70-04877

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
For primary bibliographic entry see Field 06E.
W70-04878

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
For primary bibliographic entry see Field 06E.
W70-04879

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS; GROUNDWATER; AND A PROPOSED WATER DIVERSION ACT),
For primary bibliographic entry see Field 06E.
W70-04880

EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
Iowa State Water Resources Research Inst., Ames.

Surendera Kumar, and Howard P. Johnson.
Available from the Clearinghouse as PB-190 355, $3.00 in paper copy, $0.65 in microfiche. Partial Completion Report, Iowa State Water Resources Research Institute, January 15, 1970. 101 p, 5 tab, 31 fig, 33 ref, 2 append. OWRR Project No. B-005-IA.

Descriptors: Watershed hydraulics, Drainage, Iowa, *River flow, Channel flow, Channel improvement, Flood control, *Drainage effects, Controlled drainage, *Discharge (Water), Mannings equation.
Identifiers: Boyer River, *Flood waves.

Many Iowa rivers have been straightened and leveed with the objective of achieving drainage and flood control on the riparian land. Although these methods have proved beneficial to the land along the reach straightened, they have often resulted in damage to the downstream land owner's property by increasing the discharge, thus forcing the downstream owners to repair or improve their part of the channel. Litigation among drainage districts often results with downstream districts claiming partial reimbursement of the construction and maintenance costs from the districts upstream. This study was conducted to evaluate the physical effects of river straightening on the movement of flood waves with the objective of arriving at a method for the equitable apportionment of construction and maintenance costs among beneficiaries. (Author)
W70-04984

MARKOV MODELS FOR FLOW REGULATION,
Cornell Univ., Ithaca, N.Y. School of Civil Engineering.
For primary bibliographic entry see Field 06A.
W70-04987

INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
Harvard Univ., Cambridge, Mass. Harvard Development Advisory Service.
For primary bibliographic entry see Field 06A.
W70-04988

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
Battelle Memorial Inst., Columbus, Ohio.
H. R. Hamilton, S. E. Goldstone, F. J. Cesario, D. C. Sweet, and D. E. Boyce.
Final Rep, Susquehanna River Basin Group, August 1966. 25 p, 14 fig, 11 tab, 12 append.

Descriptors: *Mathematical models, *Economics, *River basins, *Water utilization, *Water resources development, Investment, Water quality, Water shortage, Population, Employment, Social aspects.
Identifiers: Susquehanna River.

The report summarized a three-phase research program during which a dynamic mathematical model of the economy of the Susquehanna River Basin was developed. The model integrated population, employment, and water resource variables that had been treated independently previously and was capable of generating economic and water-use projection for the Basin under a wide variety of alternative assumptions. Major conclusions of the study were (a) the water resource of the Basin appeared adequate to support economic growth for the foreseeable future without the construction of major systems of river works, (b) water quality in the Basin was generally good, (c) investment in water treatment and distribution systems than by a shortage of water resources, and (d) the usefulness of a computer simulation for regional economic and regional resource studies was demonstrated. (Thiuri-Cornell)
W70-04992

METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
Hydrometeorological Centre, Moscow (USSR).
E. S. Zmieva.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 641-650, 1966. 10 p, 5 fig, 17 ref.

Descriptors: *Streamflow forecasting, *Water management (Applied), Runoff forecasting, Routing, Reservoir design, Regulation, Water balance, Hydrologic budget, Flood routing, Model studies, Water storage, Reservior yield, Safe yield.
Identifiers: *USSR.

The methods for forecasting water inflow to reservoirs in the USSR are considered using the Volgo-Kama hydro-electric power stations as an example. The methods for forecasting are based on water balance of catchment areas. A series of correlative relationships is presented in the form of diagrams or empirical formulas. Equations of water balance of the reservoirs and section of the river between the two hydrometric gages as well as the data of river runoff, feeding a reservoir or a river section, are used to calculate water inflow. Flood wave transformation is taken into account be means of lag-time curves. Calculations are carried out on an analog computer or electronic computers. (Knapp-USGS)
W70-05019

GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
Water Research Association, Medmenham (England).
Jennifer Jones, and J. A. Cole.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 611-618, 1966. 8 p, 6 fig, 2 ref.

Descriptors: *Reservoir yield, *Reservoir storage, *Statistical methods, Draft-storage curves, Probability, Water-level fluctuations, Safe yield, Reservoir yield, Reservoir operation, Water management (Applied).
Identifiers: Reservoir depletion probability.

The long-term probability of emptiness of a reservoir is calculated for various possible inputs. The input frequencies are given by four parameters that define Gaussian or gamma functions for the gain and depletion seasons. By expressing the reservoir volume in ratio to the average annual gain, the computed results may be expressed in dimensionless fashion. (Knapp-USGS)
W70-05020

BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
State Hydrological Inst. (USSR).
N. E. Kondratjev.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 804-811, 1966. 8 p, 4 fig.

Descriptors: *Bank erosion, *Reservoirs, *Waves (Water), Sedimentation, Sediment transport, Currents (Water), Water levels, Winds, Erosion.
Identifiers: Reservoir bank erosion.

Methods are given for calculating bank erosion and final stable bank form in new reservoirs. The effects of longshore currents on sediment transport and the shape of banks and depositional terraces are included. Wave erosion is estimated by theoretical calculation or wind and wave energy relations. (Knapp-USGS)
W70-05022

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
Geological Survey, Tucson, Ariz.
For primary bibliographic entry see Field 02E.
W70-05023

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
Soil Conservation Service, Portland, Oreg. Engineering and Watershed Planning Unit.
For primary bibliographic entry see Field 02J.
W70-05024

SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
Soil Conservation Service, Washington, D.C. Engineering Div.
For primary bibliographic entry see Field 02J.
W70-05025

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
Zuider Zee Works (Netherlands). Hydrology Section.
For primary bibliographic entry see Field 08A.
W70-05027

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
Electricite de France, Chatou. Centre de Recherches et d'Essais.
J. Bernier.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 575-589, 1966. 15 p, 3 fig, 7 ref, append.

Descriptors: *Reservoir operation, *Water management (Applied), *Water storage, *Safe yield, *Statistical methods, Markov processes, Reservoir yield, Runoff forecasting, Regulation, Multiple-purpose reservoirs, Probability.
Identifiers: Reservoir operation policy.

Various methods for determination of the safe yield of a storage reservoir are discussed. It appears that all the usual methods are based upon different definitions of the safety and therefore solve different problems. The definition of safe yield based upon the probability of failure is discussed and methods based upon the theory of Markov processes are presented. The safe yield of a reservoir clearly depends on the operation policy, particularly in the case of multipurpose reservoir. (Knapp-USGS)
W70-05028

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
Water Research Association, Medmenham (England).
J. A. Cole.
French summary included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 590-597, 1966. 8 p, 3 fig, 4 tab, 13 ref.

Descriptors: *Reservoir yield, *Statistical methods, Reservoir operation, Water management (Applied), Probability, Safe yield, Runoff forecasting, Regulation, Computers.
Identifiers: Net additions to storage.

Moran's transition matrix theory is applied to a water reservoir by considering seasons of irregular length with alternating gain and loss of contents. The method is illustrated for the case of an off-channel reservoir replenished from a river, using pumps of limited capacity, but is shown to be more generally applicable. Using Lloyd's bivariate matrix procedure, the importance of serial correlation of seasonal inflows is assessed, and an empirical adjustment of the probability of emptiness is established. (Knapp-USGS)
W70-05029

DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
Electricite de France, Grenoble. General Technical Div.
M. M. Lugiez, and Andre Douillet.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 598-610, 1966. 13 p, 3 fig, 2 tab.

Descriptors: *Reservoir yield, *Reservoir operation, *Draft-storage curves, Electric power, Water levels, Water storage, Statistical methods, Stage-discharge relations, Reservoir storage, Water management (Applied).
Identifiers: France, Reservoir capacity.

Control of water in hydroelectric reservoirs requires an accurate knowledge of the relation between storage and water level. Determination of this relation is actually done by Electricite de France from stereophotographs taken from an aircraft, combined with the use of an electronic computer which determines the elementary surfaces and then the volumes. Measurements made with manometers need important corrections to take into account variations of atmospheric pressure, density and compressibility of water. In some places, the disposable volume in a reservoir can change considerably in time because of silting. When the reservoir cannot be drained off entirely, bottom topography is determined by means of 'ultrasonics' emitted from a boat. When the reservoir can be entirely drained off, volumes of sediment are determined by means of periodical stereophotographs from an aircraft. Stream-gaging by dilution methods is very useful. Study of floods is facilitated by use of information from a system of automatic measurement stations located within the drainage basin above the reservoirs. (Knapp-USGS)
W70-05030

PROBABILISTIC RESERVOIR DESIGN,
Lancaster Univ., Bailrigg (England). Dept. of Mathematics.
E. H. Lloyd.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 619-625, 1966. 7 p, 19 ref.

Descriptors: *Water management (Applied), *Reservoir design, *Simulation analysis, *Probability, Markov processes, Stochastic processes, Statistical methods, Streamflow forecasting, Reservoir yield, Safe yield.
Identifiers: Autocorrelation.

Methods of calculating probabilities of reservoir contents by statistical methods are reviewed. The models describing reservoir filling are stochastic, autocorrelative, and seasonal. Systems involving several streams and reservoirs, in which flood prevention, flow regulation, drought-remedial water storage, power generation, recreation, and other uses are planned, can at present be dealt with only by simulation. The method discussed analyzes single-purpose single reservoir systems by probability theory and suggests methods of extension by models. (Knapp-USGS)
W70-05031

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
Ente Nazionale per l'Energia Elettrica, Venice (Italy).
Giorgio Conci.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 626-632, 1966. 7 p.

Descriptors: *Water management (Applied), *Reservoir design, *Streamflow forecasting, *Statistical methods, Probability, Reservoir yield, Safe yield, Hydrologic data, Stochastic processes, Optimization.
Identifiers: Reservoir yield forecasting.

To determine the exact capacity of a hydro-electric reservoir it is necessary to know both the precise water availability at chosen degrees of industrial risk, and their exact annual distribution. The presence of an anomalous year can alter the exact determination of hydraulically available resources, and the common application of the distribution of the standard year cannot be considered thoroughly reliable as it may often been based on an entirely coincidental occurrence. Correct determination of water availability is discussed. Such results are easily obtainable by applying a method based on the calculus of probability to obtain an expression for planning the most economical oversize to be assigned to the reservoir in order to safely allow variations of distribution. (Knapp-USGS)
W70-05032

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
Reditelstvi Vodnich Toku, Prague (Czechoslovakia).
Vladmir Soucek.
In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 633-640, 1966. 8 p, 2 fig, 4 tab, 12 ref.

Descriptors: *Water resources development, *Planning, *Water management (Applied), Probability, Statistical methods, Stochastic proscesses, Meteorology, Climatology, Runoff forecasting.
Identifiers: *Czechoslovakia.

The economics of integrated use of surface water resources and the implementation of the Czechoslovakian State Hydrological Plan are discussed. Probability studies are used to predict reservoir contents and to plan dam construction. The autocorrelation coefficient of annual flows is used as a tool for improving economic design and for using water storage systems more efficiently. (Knapp-USGS)
W70-05033

USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).
For primary bibliographic entry see Field 02E.
W70-05034

4B. Groundwater Management

CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
Geological Survey, Salt Lake City, Utah.
For primary bibliographic entry see Field 02K.
W70-04579

REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
California State Dept. of Water Resources, Los Angeles.
Thelma A. Johnson, and Helen J. Peters.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 493-499, 1967. 7 p, 1 fig.

Descriptors: *Conjunctive use, *California, *Water resources development, Water management (Applied), Optimum development plans, Economics, Planning, Water storage, Water rights.
Identifiers: *California Water Plan.

California's surface and groundwater resources have been developed separately with a minimum of conjunctive operation. Groundwater development has been local, while surface water development and transportation has extended to large developments with major transportation systems. The California Water Plan outlines far-future development of surface and groundwater resources, but the Plan does not provide a staged development. Current continuing staging studies are designed to produce and continually refine a time-related economic plan to meet California's water needs. Full integration of the groundwater and surface water resources of yield, storage capacity, water-in-storage and transmission capacity are necessary for proper project staging. The planned integration must be staged with a proper framework of economic criteria. Economic criteria and possible alternative physical possibilities are explored. Some project purposes, benefit measurement techniques, and economic demand techniques are identified. Successive approximation steps in applying the economic criteria are outlined. Questions of conflict between economic benefits and costs at the local and at the regional level and administrative considerations are explored. (Knapp-USGS)
W70-04604

INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
Public Health and Epidemiology Station, Miskolc (Hungary); and Public Health Inst., Budapest (Hungary).
A. Fazold, Zs. Biro, S. Takacs, and K. Schiefner.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 271-277, 1967. 7 p, 4 fig, 1 tab, 2 ref.

Descriptors: *Water storage, *Artificial recharge, *Pit recharge, Water spreading, Water treatment, Flooding, Unsteady flow, River flow, Observation wells, Water quality, Water levels, Dissolved oxygen.
Identifiers: *Hungary.

Five years of research on the chemical, biological and bacteriological changes at artificial recharge of groundwater showed that the periodical operation of a new recharge basin has a harmful effect on the water quality in a coarse sandy-pebble aquifer, and the minimal distance between the wells and recharge basins should be 50 meters. In the case of a short retention of recharge water in the ground, the free carbonic acid, the total hardness, the iron and manganese decrease, and the quantity of the dissolved oxygen and the pH-value increase. In a long retention the free carbonic acid and iron content will rise, the quantity of dissolved oxygen will not vary, and the value of pH will decrease. (Knapp-USGS)
W70-04605

FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 02G.
W70-04607

ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
I. S. Glazunov.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 237-242, 1967. 6 p, 2 fig.

Descriptors: *Artificial recharge, *Recharge wells, *Saline water-freshwater interfaces, Water storage, Aquifers, Groundwater movement, Water yield, Saline water intrusion.

Identifiers: Fresh water lenses.

The problems of artificial formation of new fresh groundwater lenses as well as replenishment of existing ones by means of a system of fully penetrating recharge and pumped wells are discussed. The technique allows formation of the lateral boundary of a lens to be calculated. The calculation relationships have been obtained for constant and exponentially changing flows of recharge wells. Piston-like displacement of saline water by fresh water is assumed. Solutions are given for 3 recharge wells at the corners of an equilateral triangle, 3 recharge wells in the corners of an equilateral triangle with a pumped well in the center, 4 recharge wells in a quadrangle, and 4 wells in a quadrangle with a pumped well in the center. (Knapp-USGS)
W70-04608

CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
Technion-Israel Inst. of Tech., Haifa. Sanitary Engineering Lab.; and Agricultural Research Service, Bushland, Tex. Southern Plains Branch.
M. Rebhun, and V. L. Hauser.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 218-228, 1967. 11 p, 9 fig, 8 ref.

Descriptors: *Artificial recharge, *Water treatment, *Coagulation, Electrolytes, Clays, Turbidity, Injection wells, Permeability, Filtration, Texas, Playas, Water spreading.
Identifiers: Polyelectrolyte coagulation.

Storm runoff water is a good source of additional water supply for arid and semiarid regions; however, it must be stored for later use. Storage of these waters in aquifers by artificial recharge is hindered by suspended solids in the water. For recharge by injection through wells, removal of suspended solids must be nearly complete. Polyelectrolyte flocculants effectively clarify suspensions typical of flood runoff water. A simple field system was built and tested, and all elements of a complete system including treatment with polyelectrolytes, a simple clarification system, and groundwater recharge through wells were combined into a successful operating unit. (Knapp-USGS)
W70-04609

A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
Alberta Univ., Edmonton; and Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
Srisakdi Charmonman, M. R. Carstens, and George D. May.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 374-382, 1967. 9 p, 4 fig, 2 tab, 6 ref. OWRR Project B-003-GA.

Descriptors: *Artificial recharge, *Saline water intrusion, *Groundwater barriers, *Canal seepage, Groundwater movement, Saline water-freshwater interfaces, Aquifers, Coasts, Canals, Deltas.
Identifiers: Saline water barriers.

The seepage flow pattern is determined for flow from a fresh-water canal which parallels the sea. Numerical results are presented for cases in which the fresh-water seepage from the land is a small fraction of the fresh-water seepage from the canal. In other words, the fresh-water flow from the canal acts as a dam forcing the interface between the sea water and the fresh water down to a lower elevation. The solution of Laplace's equation is obtained by numerical methods for this flow situation with the boundary conditions involving a water table and a density interface. The possibility of using a fresh-water canal for agricultural reclamation of sea-water intruded deltas and marshes is discussed. (Knapp-USGS)
W70-04610

FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
V. D. Grodzensky.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 360-364, 1967. 5 p, 2 fig.

Descriptors: *Saline water-freshwater interfaces, *Artificial recharge, *Irrigation water, Pit recharge, Canal seepage, Infiltration, Groundwater movement, Water quality, Water levels.
Identifiers: *USSR, Fresh-water lenses.

The formation of fresh water lenses in saline aquifers by canal or pit infiltration is analyzed. Analytical relationships are developed to show water movement, interface movement, and the effects of varying water density. The solutions obtained were verified by comparison with results of a Hele-Shaw model study. (Knapp-USGS)
W70-04611

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
Windsor Univ. (Ontario). Dept. of Civil Engineering and Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
D. E. L. Maasland, and M. W. Bittinger.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 350-359, 1967. 10 p, 5 fig.

Descriptors: *Saline water intrusion, *Aquifers, *Recharge, *Hydraulic models, Model studies, Groundwater movement, Permeability, Saline water-freshwater interfaces, Drainage, Water yield, Mixing, Salinity.
Identifiers: *Hele-shaw models.

The effluent from drains in a saline water aquifer recharged with fresh water is a mixture of salt and fresh water. A Hele-Shaw model study was conducted to determine the rate of quality change of drain effluent for various conditions of drain spacing, thickness of aquifer, permeability, and recharge rate. A uniform aquifer, a layered aquifer (top layer 12 times as permeable as the bottom), and a layered aquifer (bottom layer 6 times as permeable as the top) was studied. Results are presented in the form of dimensionless charts, containing such variables as drain spacing, thickness of aquifer, permeability, recharge rate, and porosity. The charts are used to predict the salt concentration of the drain effluent at any time for various magnitudes of the variables. (Knapp-USGS)
W70-04612

SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 02L.
W70-04613

ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
Resources for the Future, Inc., Washington, D.C.
Richard J. Frankel.
Artificial Recharge and Management of Aquifers, Symposium of Haifa (March 19-26, 1967), International Association of Scientific Hydrology, Publication No 72, p 289-301, 1967. 13 p, 1 fig, 5 tab, 44 ref.

Descriptors: *Water reuse, *Artificial recharge, *Tertiary treatment, *Reclaimed water, *Economic feasibility, Cost-benefit analysis, Water demand, Water requirements, Arid lands, Humid lands.
Identifiers: Washington (D.C.).

A research project was undertaken to determine whether or not waste reclamation could be economically competitive with other water sources for municipal water supply. Numerous advanced waste treatment systems and recycle schemes were evaluated. Waste-water renovation through groundwater recharge proved to be the most feasible solution to reclamation of the effluent of any type treatment plant today. Further study has evaluated the chemical and physical limitations of artificial recharge using municipal wastes; the economic trade-offs between additional treatment prior to recharge and greater land utilization; and the break-even point for land values as a function of economics of scale. Finally the economics of a particular case-study in the arid West of the United States is discussed as well as proposed scheme for converting the nation's capital, Washington, D.C., in the humid East from using solely surface water supplies to using artificial recharge of undeveloped aquifers for future expansion of water supplies. (Knapp-USGS)
W70-04614

CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Cincinnati Water Research Lab.; and Cincinnati Univ., Ohio. Dept. of Mathematics.
For primary bibliographic entry see Field 02K.
W70-04615

THE NEBRASKA WATER QUALITY SURVEY,
Nebraska Univ., Lincoln. Coll. of Agriculture and Home Economics.
For primary bibliographic entry see Field 02K.
W70-04616

A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
Oklahoma State Univ., Stillwater.
For primary bibliographic entry see Field 02F.
W70-04619

ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
Louisiana Water Resources Research Inst., Baton Rouge.
Laurence H. Falk.
Available from the Clearinghouse as PB-190 196, $3.00 in paper copy, $0.65 in microfiche. Louisiana Water Resources Research Institute Bull. GT-3, La. State Univ, Baton Rouge, 1970. 76 p, 9 tab, 14 fig, 79 ref, append. OWRR Projects B-001-LA, B-003-LA and B-005-LA.

Descriptors: *Marginal costs, *Capital costs, Cost comparisons, *Conjunctive use, Alternative costs, Water rights, Water management (Applied), Resource allocation, Economic efficiency, Prices, Discriminatory pricing, Water transfer, *Assessments, Tax rate, *Discount rate, Interest rate, *Cost-benefit analysis, *Benefit-cost ratio.

Existing water laws allow the misallocation of water because it is not being put to its most valued uses. Water should be subject to unconditional ownership and purchased or sold at will as long as the price reflects its marginal social cost. The present-value unit cost of replacement water produced by a private project will be less than that produced by a non-profit community project because of the corporate income tax structure, if the cost of capital is the same and the returns to outlay are constant. However, owing mainly to unequal discount rates, a community project will be more favorable, according to the benefit-cost ratio between the cost of purchasing water from the community project and the cost of the community project. Differences between the community and the national social discount rates will generally give ambiguous comparisons of economic efficiency. In Los Angeles County, water resources are misallocated because ad valorem taxes partially finance variable production costs. In additon, the prices of water imported

by the Metropolitan Water District have not reflected the marginal social costs. Efficiency could be restored by: use of pumping charges instead of ad valorem taxes; discontinuance of mandatory sales of surplus-water rights; institution of bidding for water rights; and setting of firm prices for imported water.
W70-04650

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 05D.
W70-04712

LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
Louisiana State Univ., Baton Rouge.
Raphael G. Kazmann, and Marla M. Heath.
In: Transactions-Gulf Coast Association of Geological Societies, Vol. XVIII, 1968, p. 108-113, 8 fig, 6 ref.

Descriptors: *Groundwater, *Artificial recharge, *Land subsidence, *Withdrawal, *Overdraft, Aquifers, Groundwater recharge, Subsidence.
Identifiers: *New Orleans.

The land surface of the New Orleans area is subsiding in a manner similar to that of other deltoric deposits in the Gulf Coast Plain. Superimposed on this broad subsidence pattern is another (more local in nature) that is associated with the lowering of the piezometric surface of the principal aquifer of the area, the '700-foot' sand. Published elevations of bench marks show an elevation decrease of as much as 1.7 feet between 1938 and 1964. The long-term implications to the city of New Orleans of the subsidence produced by groundwater offtake are significant. The land surface is already so low that additional subsidence should not be tolerated. Groundwater offtakes should not be increased; if possible, groundwater production within the area should be curtailed. If the aquifers (primarily the '700-foot' sand) are to be used in the future, they should be artificially recharged to reduce the net withdrawal of water. Four recommendations for detailed analysis of this phenomenon are forwarded: (1) present studies of local groundwater conditions should be immediately expanded and intensified; (2) the present bench mark system should be expanded; (3) the bench marks should be relevelled more frequently than in the past; and (4) the level lines should be tied and adjusted to stable inland bench marks. (Davis-Chicago)
W70-04833

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
Louisiana Water Resources Research Inst., Baton Rouge.
Raphael C. Kazmann.
Available from the Clearinghouse as PB-190 358, $3.00 in paper copy, $0.65 in microfiche. Louisiana Water Resources Research Institute, Bulletin No. 5, Feb. 1970. 126p, 18 fig, 17 tab, 18 ref, 6 append. OWRR Projects A-001-LA; A-004-LA; B-001-LA thru B-005-LA.

Descriptors: *Water supply, *Groundwater, *Surface waters, Aquifers, Groundwater recharge, Saline water intrusion, Hydrogeology, *Water spreading, Water quality, Water management (Applied), *Land subsidence, *Economic efficiency, *Water costs, Marginal costs, Discount rate, *Legislation, *Water law, Reparian rights, *Water transfer, Reasonable use, Administrative agencies, River flow, Systems analysis, Pipelines, Amite River (La), Baton Rouge (La).

A principal Baton Rouge aquifer has become degraded by saline water that is drawn by heavy industrial pumping from a trapped source west of the offtake area. Because this water moves through a geological constriction, its flow is limited. Further northward movement can be halted by pumping it from waste wells. Later, injection of fresh water from a shallower aquifer, which is hydraulically connected to the Mississippi River, could form a pressure barrier against eastward flow. The maximum land subsidence resulting from continued drawdowns in the 10 presently-used aquifers may reach 5 feet. Fresh water imported from the Amite River is proposed as the future supply. This water, after its infiltration in spreading grounds, would be withdrawn through wells and then transported by pipeline to the industrial area. For peak-demand storage, part of this water could be injected into several aquifers, which would then serve as short-distance distributaries. Proposed legislation concerning water rights and administrative agencies, predicted water costs, an optimized pipeline system, and the hydrography of the Amite River are given in the appendices.
W70-04856

WATER RIGHTS IN TENNESSEE,
For primary bibliographic entry see Field 06E.
W70-04874

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
For primary bibliographic entry see Field 06E.
W70-04876

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
For primary bibliographic entry see Field 06E.
W70-04877

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS; GROUNDWATER; AND A PROPOSED WATER DIVERSION ACT),
For primary bibliographic entry see Field 06E.
W70-04880

GEOLOGICAL SUBSIDENCE,
For primary bibliographic entry see Field 02F.
W70-04908

4C. Effects on Water of Man's Non-Water Activities

PREDICTING THE EFFECT OF CLEAR-CUTTING ON STREAM TEMPERATURE,
Oregon State Univ., Corvallis. School of Forestry.
George W. Brown.
Journal of Soil and Water Conservation, Vol 25, No 1, p 11-13, January-February 1970. 3 p, 2 fig, 2 tab, 10 ref.

Descriptors: *Water temperature, *Clear-cutting, Forest management, Cutting management, Land clearing, Lumbering, Watershed management, Heat budget, Solar radiation, Discharge (Water), Thermal pollution, Water pollution sources.
Identifiers: Stream temperatures.

The temperature change that occurs between two points on a stream is directly proportional to the surface area of the stream and the heat load applied between these points. It is inversely proportional to the flow. Good estimates of the heat load can be made with solar radiation data if the stream is uniformly exposed to sunlight. Foresters can use this technique to predict the effect of clear-cutting on stream temperature. (Knapp-USGS)
W70-04556

SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
Soil Conservation Service, East Lansing, Mich.
For primary bibliographic entry see Field 02J.
W70-04557

THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
Geological Survey, Washington, D.C. Water Resources Div.
William J. Schneider.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium, No 2, Austin, Texas, October 1968, p 165-168, University of Texas Press, Austin and London, 1969. 4 p.

Descriptors: *Planning, *Urbanization, *Data collections, *Water management (Applied), Research and development, Water resources development, Water supply, Waste disposal, Storm runoff.
Identifiers: U.S. Geological Survey, Urban hydrology.

The Water Resources Division of the U.S. Geological Survey is currently expanding its role in urban hydrology as rapidly as possible to meet new demands. Almost since the first stream-gaging stations were established, more than 80 years ago, water-resources data have been collected in urban areas. Today, some data are available for every one of the 222 standard metropolitan areas in the United States. In addition to the collection of basic data, the Water Resources Division has conducted studies either within or including urban areas. These have resulted in numerous reports published in the Survey publication series and in outside technical journals. In recent years, the emphasis of these studies has been on the assessment of changes in the water resources caused by urbanization. Storm drainage today is still largely designed on the basis of the empirical rational formula using rainfall intensity modified by a coefficient of runoff. The inefficiency of this method is well recognized. Greater knowledge of the part of the hydrologic cycle involving rainfall-runoff relations in urban environments is needed. A study, currently under way, will consider the data needs for urban runoff studies, appraise available and needed instrumentation for collection of these data, and advise on types of networks for collection of these data. This study is for design of pilot areas. (See W70-04723). (Knapp-USGS)
W70-04573

URBAN EFFECTS ON WATER YIELD,
Geological Survey, Menlo Park, Calif.
Arvi O. Waananen.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 169-182, University of Texas Press, Austin and London, 1969. 14 p, 7 fig, 2 tab, 16 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Storm runoff, *Water supply, Land use, Water yield, Hydrology, Hydrographs, Peak discharge, Hydrograph analysis, Meteorology, Sewers, Storm drains, Recharge, Sewage disposal, Waste disposal.
Identifiers: Urban hydrology, Urban meteorology.

Urban development has a significant impact on hydrologic relations. The results of various studies demonstrate the type and magnitude of many of the effects on yield. These may be summarized as including: (1) Increase in total yield from stormflow and in annual discharge: (2) decrease in base flow of those streams that remain under generally natural conditions; (3) modification of low flow of streams influenced by the importation of water, the use of which results in discharge of wastewater. This includes the increase of low flow in streams that receive septic-tank drainage, or effluents from sewage-treatment plants, or from industrial plants; (4) decrease in recharge to the underlying groundwater basins; and (5) increase in precipitation in urban areas and corresponding increase in yield.

The principal effect of urban development on yield is an increase in direct runoff. The cumulative effect of increase in stormflow from urban areas, particularly in regions of strip cities and the megalopolitan complexes developing in several areas, may be substantial on downstream receiving channels. (See W70-04723). (Knapp-USGS)
W70-04574

MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
Utah Water Research Lab., Logan.
J. Paul Riley, and V. V. Dhruva Narayana.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 183-200, University of Texas Press, Austin and London, 1969. 18 p, 14 fig, 3 tab, 7 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Computer models, *Analog models, Analog computers, Simulation analysis, Hydrograph analysis, Storm runoff, Peak discharge.
Identifiers: Urban hydrology, Austin (Texas).

In the synthesis of hydrograph characteristics of small urban watersheds, the distribution of the water among the various phases of the runoff process is attempted by the concept of 'equivalent rural watershed.' For a given input into both the models (Urban and its equivalent rural watershed), the outputs must be identical. The hydrograph of outflow from an urban watershed is obtained by chronologically deducting the losses due to interception, infiltration, and depression storage from precipitation on the equivalent rural watershed and then routing it through the surface and channel storages. This is being approached by computer simulation. Testing and verification of the basic mathematical model is being done by using observed rainfall and runoff data from well-instrumented runoff areas. Coefficients representing interception, depression storage, and infiltration are determined by the trial and error process on the analog computer in such a way that the outflow hydrograph predicted by the model is nearly identical to the measured prototype hydrograph. Relationships between these coefficients and various urbanization characteristics or parameters are established. Sensitivity studies which investigate the significance of each of the watershed coefficients on the outflow characteristics are also undertaken. (See W70-04723). (Knapp-USGS)
W70-04575

EFFECTS OF URBANIZATION ON PEAK FLOWS,
Michigan Univ., Ann Arbor.
E. F. Brater, and Suresh Sangal.
Research supported by FWPCA, Mich State Highway Dep and U. S. Bureau of Public Roads. In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 201-214, University of Texas Press, Austin and London, 1969. 14 p, 8 fig, 36 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Storm runoff, *Routing, Hydrograph analysis, Model studies, Mathematical models, Simulation analysis, Infiltration, Runoff, Overland flow, Peak discharge, Floods.
Identifiers: Urban hydrology.

Study of the effect of urbanization on peak flows requires the best possible knowledge of the runoff process. The volume of surface runoff is the rainfall minus infiltration and permanent retention. Some of the impermeable portions of basins result from urbanization and their magnitude must be considered in computing the infiltration capacity. Hydrologically significant impermeable area is probably smaller than the actual impermeable area, and there is evidence that it is related to population density. For basins near Detroit the significant value varies from 1% to 10%, for population densities varying from about 500 to 7,000 per square mile. Many routing techniques may provide the basis for a mathematical model of the hydraulics of storm runoff. One method of evaluating the influence of urbanization on the runoff hydrograph is to study relationships between unit hydrograph shape parameters and some measures of drainage basin characteristics. Much work has been and is being done to help find better ways of predicting peak flows from rainfall, and more emphasis is being placed on the determination of the effect of urbanization. (See W70-04723). (Knapp-USGS)
W70-04576

URBAN EFFECTS ON THE UNIT HYDROGRAPH,
Tracor, Inc., Austin, Tex.; and Texas Univ., Coll. of Engineering.
William H. Espey, Jr., David E. Winslow, and Carl W. Morgan.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 215-228, University of Texas Press, Austin and London, 1969. 14 p, 10 fig, 4 tab, 15 ref. OWRR Project C-1098 (1590).

Descriptors: *Urbanization, *Storm runoff, *Hydrograph analysis, *Frequency analysis, Hydrology, Rainfall-runoff relationships, Peak discharge, Floods, Unit hydrographs.
Identifiers: Urban hydrology, Urban watersheds.

Summaries are presented of work concerning peak floods for urban areas and of a recent study concerning watersheds in Houston, Texas. Increased urbanization results in increased peak flows and accentuated high and low flows. Equations presented show that peak flows may be expected to increase from two to four times that of the flow from the undeveloped watersheds, depending upon the type of channel improvement, amount of vegetation in the channel, and the type of secondary drainage system. The capacity of the secondary drainage facilities may have a limiting effect on the peak discharge. (See W70-04723). (Knapp-USGS)
W70-04577

EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
Turner, Collie and Braden Co., Inc., Houston, Tex.
Donald VanSickle.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 229-254, University of Texas Press, Austin and London, 1969. 26 p, 17 fig, 4 tab, 17 ref.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Unit hydrographs, *Synthetic hydrology, Rational formula, Storm runoff, Peak discharge, Floods, Hydrograph analysis, Routing.
Identifiers: Houston (Tex), Urban hydrology.

An example is given of the adaptation of preliminary research data to the development of new drainage design criteria for a major metropolitan area. The new criteria should be closer to the actual needs than the old rational method criteria. The Houston metropolitan area, one of the most rapidly urbanizing areas in the United States, was used to establish and test new urban runoff criteria. In order to apply urbanization factor data to design, the following procedures are followed: (1) Develop the mean basin length and mean basin slope values from topographic maps; (2) estimate the degree of development anticipated in the watershed for the period of design; (3) estimate drainage density for each of the areas of use; (4) multiply the drainage density by the area for each type of land use to get total channel length; (5) determine the basin factor; (6) from the curves, determine the time to peak and the unit hydrograph peak for the degree of development involved; and (7) develop the unit hydrograph. A simpler way to use the criteria is to develop them as empirical curves of drainage area versus discharge, of specific use only in the urban area and for the storm frequencies for which they are designed. Synthetic unit hydrographs were prepared and tested for about 50 drainage areas in the Houston areas. (See W70-04723). (Knapp-USGS)
W70-04578

SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 08A.
W70-04694

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
Texas Univ., Austin. Dept. of Civil Engineering.
Walter L. Moore, and Carl W. Morgan.
Water Resources Symposium No 2, Austin, Texas, October 1968. Published by Univ of Texas Press, Austin and London, 1969. 289 p.

Descriptors: *Urbanization, *Rainfall-runoff relationships, *Hydrograph analysis, *Water quality, Flood control, Reservoirs, Water yield, Hydrologic budget, Planning, Water management (Applied), Hydrology, Floods, Peak discharge, Model studies, Hydraulic models, Mathematical models, Computer models, Analog models.
Identifiers: Urban hydrology.

This special lecture series was arranged to present the most advanced approaches to evaluating the effects of watershed changes on streamflow. To an increasing degree man's activities are altering the hydrologic characteristics of watersheds, both rural and urban, and it is urgent to know the character and extent of the changes and how they affect plans for development. Numerous field studies designed to evaluate the effect of specific watershed changes by comparisons between watersheds have been in operation for sufficient time to build up a significant length of record. New methods of computer simulation of watersheds have reached a stage of development to offer an attractive tool for attacking the problem in new ways. The effects of the changes can best be evaluated when the entire performance of the watershed is understood in detail. Then all of the physical processes can be followed and the performance of the watershed can be simulated by numerical or analog techniques which correspond to the physical processes. Watershed changes produce effects on both the amount and the quality of streamflow. The topics discussed include model studies, land treatment in rural watersheds, flood control structures, rural pollution, the effects of urbanization on peak flow, the effects of urbanization on water yield, and urban water quality changes. (See also W70-04724-W70-04730 and W70-04571-W70-04578). (Knapp-USGS)
W70-04723

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
Texas Water Development Board, Austin; and International Boundary and Water Commission, El Paso, Texas.
Lewis B. Seward, and John J. Vandertulip.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 37-43, University of Texas Press, Austin and London, 1969. 7 p, 1 fig.

Descriptors: *Data collections, *Water resources development, *Texas, *Planning, Hydrologic data, Investigations, Routing, Rainfall-runoff relationships, Urbanization, Water utilization, Water requirements, Water management (Applied).
Identifiers: *Texas Water Plan, *Data requirements.

Studies for the Texas Water Plan must include computations to determine runoff accurately, under all conceivable conditions. These studies of the future water resources will, in effect, reduce known and correlated runoff records to virgin con-

ditions, to which present and future watershed conditions and developments can be applied. Present depletions by man of the various river basins of the state must be evaluated. Accurate data will be necessary on domestic and industrial water use; on use of water by cropped lands, noncropped lands consuming irrigation water incidental to irrigation, transbasin or subbasin diversions, and reservoir loss - including evaporation loss and evapotranspiration on deltas and lake shores. These computations will entail the observation of cropped and noncropped areas, and their rates of use of irrigation water. Rates of consumptive use will have to be determined through transfer of experimental consumptive-use data to various sites of use within river basins through empirical relationships between experimental and climatological data. The depletions at sites of use must be computed and then routed downstream to determine channel losses resulting from man-made depletions. Inflow-outflow hydrologic studies must be conducted to analyze reaches of streams and rivers. (See W70-04723). (Knapp-USGS)
W70-04724

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
Texas Univ., Austin, and Texas Tech Univ., Lubbock.
Erdal Coskun, B. J. Claborn, and Walter L. Moore.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 79-99, University of Texas Press, Austin and London, 1969. 21 p, 11 fig, 5 tab, 9 ref.

Descriptors: *Rainfall-runoff relationships, *Small watersheds, *Computer models, *Texas, Mathematical models, Simulation analysis, Hydrologic budget, Flood control, Reservoirs, Base flow, Hydrograph analysis, Water yield, Runoff, Infiltration, Evapotranspiration.
Identifiers: Mukewater Creek (Tex), Stanford Watershed Model.

The Mukewater Creek watershed in central Texas was selected to explore the application of Stanford Watershed Model IV to evaluate the effects of changes in the watershed on its output. The general approach was to determine parameters for the watershed model to fit watershed conditions during an early period, prior to changes in the watershed, and then use the model to estimate the watershed output that would have occurred later had the watershed remained in its original condition. Comparison of these estimated flows with the measured flows at later times is probably the best available measure of the effects of changes on watershed output. The digital model has been applied to the Mukewater Creek study area using the data of the three-year period, October 1955 to September 1958, prior to the construction of the floodwater-retarding structures for selection of the program parameters. For the 13 months of available record, channel losses attributable to the structures were positive for 9 months, amounting to 506 acre-feet or 7% of the flow during those months. During the other 4 months the losses with the structures were less, amounting to a total of 404 acre-feet or 17% of the flow during those months. Based on the limited data it would appear that the additional losses due to increased evapotranspiration resulting from prolonged flow in the channels were approximately balanced by the reduced losses due to less flood-bank infiltration. (See W70-04723). (Knapp-USGS)
W70-04726

URBAN EFFECTS ON QUALITY OF STREAMFLOW,
Texas Univ., Austin. Environmental Health Engineering Research Lab.
E. Gus Fruh.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 255-282, University of Texas Press, Austin and London, 1969. 28 p, 22 fig, 5 tab, 15 ref. NSF Grant GU-1963, and Texas Water Quality Bd Contract No. 68-69-281.

Descriptors: *Reservoirs, *Urbanization, *Water quality, *Stratification, *Texas, Water pollution sources, Water pollution effects, Dissolved oxygen, Aquatic bacteria, Algae.
Identifiers: Austin (Tex), Colorado River (Tex).

The effects of impoundments and urbanization on the water quality of the Colorado River of Texas were studied in the reservoirs near Austin, Texas. Lake Travis, upstream from Austin, is large and deep and has no significant input of pollution. Lake Austin, the next reservoir downstream, is much smaller and shallower, and receives some recreational and urban runoff pollution. Town Lake, in Austin, is small and narrow with predominantly river characteristics, and receives some urban runoff pollution. Oxygen concentration-water depth data for the 3 reservoirs are tabulated. In Lake Travis, even in the winter, the temperature varied with depth. During the summer, the oxygen first became depleted at the thermocline region. Throughout the fall, various depths of Lake Travis became reaerated, but oxygen-depleted waters were still passing through the penstocks in November. In winter, oxygen was present at all depths. In Lake Austin, the summer oxygen concentration in the epilimnion varied around saturation. Dissolved oxygen decreased steadily in the hypolimnion during the summer and was consistently lower above the sediments. After autumn turnover, oxygen remained uniform from top to bottom. High numbers of total and coliform bacteria were found in Lake Austin during the spring following periods of intensive rainfall. The urban stream, Barton Creek, had significantly higher concentrations of solutes, nutrients, and bacteria than Town Lake above the stream's entrance, particularly during the spring rainfall period. All of Austin's urban streams enter Town Lake and Lake Austin, with the streams from the more highly developed areas entering Town Lake. (See W70-04723). (Knapp-USGS)
W70-04727

RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
For primary bibliographic entry see Field 06B.
W70-04760

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
Geological Survey, Washington, D.C.
S. E. Rantz.
USGS Circular No. 601-B, Washington: 1970, 11 p, 1 fig, 1 map, 5 photo, 3 tab.

Descriptors: *Urbanization, *Flooding, *Flood control, Storm runoff, Land use, Zoning, Mudflows, Debris avalanches, Landslide.
Identifiers: *Urban sprawl.

The floods of January 1969 in south-coastal California provide a timely example of the effect of urban sprawl on flood damage. Despite record breaking, or near record breaking, stream discharges, damage was minimal in the older developed areas that are protected against inundation and debris damage by carefully planned flood-control facilities, including debris basins and flood-conveyance channels. By contrast, heavy damage occurred in areas of more recent urban sprawl where the hazards of inundation and debris or landslide damage have not been taken into consideration, and where the improvement and development of drainage or flood control facilities have not kept pace with expanding urbanization. (Davis-Chicago)
W70-04832

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
Western States Water Council.
Jay R. Bingham.
In Arizona Watershed Symposium, 13th, Phoenix, Arizona, September 24, 1969, Proceedings, p 29-32.

Descriptors: *Water resources development, *Watershed management, *Water transfer, *Planning, *Coordination, Water law, Interstate compacts, Regional analysis, State governments, Federal government, Federal-state water rights conflicts, Public lands.
Identifiers: *Western States Water Council, Pacific Southwest Inter-Agency Committee, Pacific Northwest River Basins Commission, Public Land Law Review Commission.

The Western States Water Council was created in 1965 to effect cooperation among the western states in the development of water resources. The council has worked to establish principles, standards, and guidelines for developing regional water programs and has completed a review of large-scale water transfer proposals. The council has also brought together the heads of the Pacific Southwest Inter-Agency Committee and the Pacific Northwest River Basins Commission in an effort to coordinate the work of these two groups. The work of the Public Land Law Review Commission is of great importance to the council and it attempts to make the Commission aware of the needs of the western states. Information gained through watershed management programs is useful to all of these council activities. (Carr-Arizona)
W70-04913

4D. Watershed Protection

FIELD EXPERIMENT ON WASHITA RIVER,
Agricultural Research Service, Chickasha, Okla. Southern Plains Branch.
Monroe A. Hartman, Arlin D. Nicks, Edd D. Rhoades, Russell R. Schoof, and Paul B. Allen.
In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 136-149, University of Texas Press, Austin and London, 1969. 14 p, 10 fig, 5 tab.

Descriptors: *Rainfall-runoff relationships, *Small watersheds, *Flood control, Dams, Reservoirs, Rain gages, Stream gages, Water yield, Runoff, Evaluation, Networks, Rainfall, Hydrograph analysis, Sediment transport, Sediment yield.
Identifiers: Southern Plains Watershed Research Center.

Initial analysis of hydrologic data from the Southern Plains Watershed Research Center, Chickasha, Oklahoma, shows that significant reductions can be expected in runoff peaks and sediment loads from watersheds treated with flood-detention dams. This has been shown with peak flow reductions of 16,400 to 8,300 cfs, 1,370 to 400 cfs, and 1,300 to 950 cfs, for three Sugar Creek storms. Sediment yield reductions with treatment were recorded on Winter Creek, where yields after treatment were only one-tenth as large as those before treatment. The effect of cover on runoff and sediment yields was measured on small watersheds. Small watersheds with poor cover had three times as much runoff and 25 times as much sediment yield as watersheds with good cover. Large flow losses from large out-of-bank flows have been recorded on the Washita River. Large flow losses have also been recorded in the physiography of a natural watershed such as Tonkawa Creek. The dense network of rain gages has shown the necessary rain-gage spacing for 95% accuracy on large and small watersheds. Data analysis currently in progress should add to the scope and reliability of the above findings. (See W70-04723). (Knapp-USGS)
W70-04572

LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
Agricultural Research Service, Beltsville, Md. Soil and Water Conservation Research Div.
L. M. Glymph, and H. N. Holtan.

In: Effects of Watershed Changes on Streamflow, Water Resources Symposium No 2, Austin, Texas, October 1968, p 44-68, University of Texas Press, Austin and London, 1969. 25 p, 17 fig, 5 tab, 22 ref.

Descriptors: *Rainfall-runoff relationships, *Agricultural watersheds, *Demonstration watersheds, Mathematical models, Model studies, Management, Evapotranspiration, Watershed management, Water utilization.
Identifiers: Watershed models.

Studies of the hydrology of farm watersheds are reviewed with emphasis on relationships between land treatment and runoff coefficients. The rate of runoff depends on the size and shape of the watershed, surface slopes, nature and amount of vegetation, soil permeability, initial soil saturation, arrangements and character of drainage channels, evaporation, storage and underground conditions, and the duration and intensity of rainfall. Experimental watershed research seeks to establish principles and describe them in numerical terms so that by knowing the geology, soils, topography, and characteristics of the stream channel system of an ungaged watershed, its performance may be predicted under various land use patterns and treatments when subject to an assumed single precipitation event or to a series of such events. A mathematical model for computing the components of watershed hydrology in their natural chronological and spatial sequences of occurrence is under study by the USDA Hydrograph Laboratory. (See W70-04723). (Knapp-USGS)
W70-04725

DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
State Inst. of Hydrology and Meteorology, Krakow (Poland).
For primary bibliographic entry see Field 02J.
W70-04751

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
Corps of Engineers, Rock Island, Ill., Iowa Univ., Ames, and Argicultural Research Service, Columbia, Mo.
For primary bibliographic entry see Field 02J.
W70-04752

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
Agricultural Research Service, Columbia, Mo. Soil and Water Conservation Div., and Missouri Univ., Columbia. Dept. of Zoology.
For primary bibliographic entry see Field 02J.
W70-04753

05. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification of Pollutants

USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,
Norges Tekniske Hoegskole, Trondheim. Dept. of Port and Ocean Engineering.
For primary bibliographic entry see Field 07B.
W70-04551

TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962-SEPTEMBER 30, 1967,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Div. of Pollution Surveillance.
John F. Kopp, and Robert C. Kroner.
Requests for report should be sent to Dept of Interior, FWPCA, Div of Pollution Surveillance, 1014 Broadway, Cincinnati, Ohio 45202. Federal Water Pollution Control Administration, Division of Pollution Surveillance Report, 1969. 207 p, 2 fig, 12 tab, 12 ref, 16 append.

Descriptors: *Water quality, *Trace elements, *Data collections, United States, Public health, Water chemistry, Mineralogy, Hydrologic data, Water quality act, Water resources, Water supply, Surveys.
Identifiers: Trace metals.

Trace elements in waters of the United States were determined from the analysis of over 1,500 samples. The minimum, maximum and mean observed values are given along with the number of positive occurrences and the frequency of detection. These data show that boron, barium and strontium were found in solution in over 98% of all samples. Zinc, iron and copper were observed with a frequency of 74 to 76%. Manganese was observed slightly less regularly at a 51% frequency and aluminum, lead, chromium, molybdenum and nickel were detected in 16 to 33% of the samples. Cadmium, beryllium, silver, cobalt, vanadium and arsenic were detected at measurable levels in less than 7% of all samples. The total body of data approximates 30,000 determinations. Based on soluble trace metals, only 0.6% exceeded the limits set by the Water Quality Criteria for public water supplies. (Knapp-USGS)
W70-04567

CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
For primary bibliographic entry see Field 05D.
W70-04586

OIL SAMPLING TECHNIQUES (A Progress Report).
Federal Water Pollution Control Administration, Edison, N.J. Water Quality Lab.

Available from the Clearinghouse as PB-190 171, $3.00 in paper copy, $0.65 in microfiche. Water Pollution Control Research Series DAST-12, Dec, 1969. 62 p, 19 tab, 11 fig, 8 ref. FWPCA Project 15080FHT--12/69.

Descriptors: Oil, *Sampling, Absorption, Separation, Analytical techniques.
Identifiers: *Oil sampling, Oil spillage, Oil slicks.

Sampling of oil in the environment, depending upon the thickness of the slick, can present certain operational problems, most paramount of which is the collection of an adequate volume of sample required for identification by chemical analyses. Several basic 'dip-stick' techniques, which are primarily applicable for sampling slicks with a thickness of greater than 2 mm, as well as suggested methods for sampling thin oil slicks are discussed and illustrated. Included in this report are preliminary results on oil entrapment by solid absorbents obtained by the Oil and Hazardous Materials Research Section, Edison, New Jersey. Also reported are results of investigations performed by foreign and U.S. scientists, using various types of sampling equipment and materials.
W70-04654

OIL TAGGING SYSTEM STUDY, Summary.
Melpar, Falls Church, Va.

Available from the Clearinghouse as PB-190 193, $3.00 in paper copy, $0.65 in microfiche. Federal Water Pollution Control Research Series DAST-11, Oct, 1969. 31 p, 88 ref. FWPCA Project 15080 DJQ--10/69, Contract No. 14-12-500.

Descriptors: Marking techniques, Tracing techniques, *Tagging, Oil, Oil wastes.
Identifiers: *Oil tagging, *Surveillance, Enforcement, *Oil pollution.

Several methods of identifying the source of oil pollution are critically examined. These methods are grouped into two categories: passive tagging and active tagging. Passive tagging assumes that oils are so chemically diverse that their contents consititute a stable chemical fingerprint that can be unequivocally disclosed in the laboratory. Active tagging requires that an inexpensive, coded material be added to oil; this material must be chemically and physically stable in both oil and oil slicks; it must also be readily identifiable by available analytical techniques; and it must have no adverse effect on the oil's subsequent use. Three methods of passive tagging (trace metals, sulfur-isotope ratios, and paper chromatography) and three methods of active tagging (halogenated polycyclic aromatics, organometallics, and coded microspheroids) have been examined. Passive tags cannot be recommended because the passive tags are quite likely to mingle, to evaporate, to be dissolved, or to be oxidized; even if these processes do not occur, they can create formidable forensic problems for the prosecution and telling counter-arguments for the defense. Since active tags are designed to be stable and identifiable, they are satisfactory for the job; and the three types of active tags reviewed show promise and merit.
W70-04655

OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
New York Operations Office (AEC), N. Y. Health and Safety Lab; Lamont-Doherty Geological Observatory, Palisades, N. Y.; Woods Hole Oceanographic Institution, Mass.; and Isotopes, Inc., Westwood, N. J.
For primary bibliographic entry see Field 05B.
W70-04704

STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
Environmental Science Services Administration, Silver Spring, Md.
For primary bibliographic entry see Field 05B.
W70-04705

LEACHING OF POLLUTANTS FROM REFUSE BEDS,
Battelle Memorial Inst., Columbus, Ohio; and West Virginia Univ., Morgantown. Dept. of Civil Engineering.
Syed R. Qasim, and Jerry C. Burchinal.
ASCE Proceedings, Journal Sanitary Engineering Division, Vol 96, No SA1, Paper 7078, p 49-58, February 1970. 10 p, 5 fig, 6 tab, 7 ref, append.
USPHS Grant EF-40 (RI).

Descriptors: *Landfills, *Leaching, *Water pollution sources, *Path of pollutants, Percolation, Garbage dumps, Seepage, Public health, Water analysis, Evaporation, Evapotranspiration.
Identifiers: Sanitary landfill leaching.

A procedure is presented for estimating theoretically the chemical quality of leachates from sanitary landfills. A theory of column chromatography was employed to determine the leaching of chloride during the movement of water through refuse beds. Generalized breakthrough curves were used to obtain the theoretical chloride concentrations. Familics of curves were then derived from experimental results, representing the ratios of various leaching materials to the theoretical chloride concentrations. A comparison of experimental and theoretical results shows good agreement. The method can be applied to the field study of existing landfills to determine the chemical composition of polluting liquid during the leaching process, if the cumulative precipitation, evaporation, evapotranspiration, runoff coefficients, and the depth of refuse beds are known. (Knapp-USGS)
W70-04714

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
Purdue Univ., Lafayette, Ind.
D. T. Lauria, and C. A. Willis.

Proceedings 19th Industrial Waste Conference, p.45-58, 1964. Engineering Extension Series 117.

Descriptors: *Waste water disposal, *Pilot plant, *Sewage treatment, *Waste water treatment, *Sludge disposal, *Data collections, *Treatment facilities, Domestic waste, Effluents, Water supply, Biological treatment, Biochemical Oxygen Demand, Screening equipment, Sludge treatment, Lagoons, Aeration, Sedimentation, Chlorination, Centrifugation, Waste waters.
Identifiers: Textile waste, Grit removal, Filters (Fluid).

At Valdese, N.C., more than 80 percent of the total waste flow consists of waste waters from the dyeing and finishing operations at textile mills. The existing sewage works are overloaded and, since the effluents are discharged to a creek flowing into a lake used for recreational and water-supply purposes, it was decided to carry out pilot-plant experiments to obtain data for the design of a new plant for biological treatment of combined domestic sewage and textile waste waters. Some results of operation of the pilot plant are summarized in tables and graphs. The method of treatment chosen was a low-loading completely-mixed process, and results showed that reductions in BOD of 90 percent could be obtained with BOD loadings of at least 2 lb. of BOD per lb. of sludge per day. The oxygen requirements of the process were estimated to determine the capacity of aeration equipment required. The proposed new plant, which will have a capacity of 3.2 m.g.d., will comprise facilities for screening and grit removal, lagoons with mechanical surface aerators, sedimentation tanks, facilities for chlorination of effluents, and a sold-bowl centrifuge for thickening excess sludge before disposal as landfill. (Livengood-Mattox North Carolina State Univ)
W70-04795

CHEMICAL NATURE OF EFFLUENTS FROM THE TEXTILE, LEATHER, AND PAPER INDUSTRIES,
M. Kehren.
Ciba Review, No 1212, p 8-12, 1957.

Descriptors: *Biochemical oxidation demand, Color, Turbidity.
Identifiers: *Permanganate value, *Textile mill wastes, Dyes.

The two most common tests for all types of water are the permanganate value and biological oxygen demand. Textile effluents can contain floating matter, settleable suspended matter, colloidal impurities, polluting substances in true solution and dyes. Textile effluents show a high degree of pollution, as evidenced by their colour, turbidity, and high permanganate value. Most effluents have high dissolved or suspended mineral and organic values, and most textile wastes are alkaline. A chart on the properties of textile wastes is included. (Robinson-North Carolina State Univ)
W70-04969

5B. Sources of Pollution

BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
Geological Survey, Denver, Colo.
Marvin C. Goldberg, and Robert L. Wershaw.
Available for sale from Superintendent of Documents U S Government Printing Office, Washington, D C, 20402-Price $3.75. Geological Survey Research 1969, Professional Paper 650-D, p D235-D239, 1969. 5 p, 3 fig, 1 tab, 16 ref.

Descriptors: *Pesticides, *Biodegradation, *Fungicides, *Bottom sediments, Aquatic microorganisms, Mud, Colorado, Aquatic microbiology.
Identifiers: Dodine, Denver (Colo).

A two-part investigation of the biodegradation of dodecylguanidine acetate (dodine), a fungicide, showed that two soil organisms, a Flavobacterium sp. and an Achromobacter sp., utilize the material as the sole source of carbon. By use of C-14-labeled fungicide, the investigation also showed that the biological content of river muds typical of the Denver, Colo., area degrades up to 5% of a dodine charge within 68 days. Preconditioning the river muds to the fungicide neither enhanced or decreased the amount of biodegradation in any of the samples tested. (Knapp-USGS)
W70-04580

STATEMENT OF CONCERN,
Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health.
E. P. Radford, I. Merz, C. Ray, R. M. Herriott, and C. W. Kruse.
Environment, Vol 11, No 7, p 18-27, September 1969. 10 p, 3 fig, 3 photo, 1 tab, 7 ref.

Descriptors: *Thermal pollution, *Radioactive wastes, *Water pollution sources, *Water pollution effects, *Estuaries, Maryland, Nuclear powerplants, Currents (Water), Dispersion, Waste dilution, Ecology, Environment.
Identifiers: Chesapeake Bay, Calvert Cliffs (Md).

The proposed Calvert Cliffs nuclear powerplant will add heat and radioactive material to Chesapeake Bay. Research on possible effects is recommended before construction is authorized. The proposed plant site is on 1135 acres of a sparsely populated section of Calvert County, Maryland, on the shore of Chesapeake Bay. The land is partially forested, and there is farming, raising of beef cattle, and residential use of some areas. Adjacent waters are used for commercial and sport fishing and water sports. The adjacent Bay is six miles wide and a maximum of 110 feet deep, and tidal flows are of greater velocity than elsewhere. It is estimated that a plume of heated water will extend outward from the plant no farther than 2000 feet. This estimate is evidently based upon modeling studies which have not been completed. The judgment to proceed with construction of such large nuclear powerplants is questioned because many environmental and public health hazards have not been satisfactorily investigated or resolved. There is no question that operation of this and other contemplated plants will alter the Bay ecology--the question is how much and in what manner and what the effect will be upon the health and safety of the public. (Knapp-USGS)
W70-04584

EARTH, AIR, WATER,
Southern Illinois Univ., Carbondale. Dept. of Biology.
Justin Frost.
Environment, Vol 11, No 6, p 14-33, July-August 1969. 20 p, 3 fig, 6 tab, 38 ref.

Descriptors: *Pesticide drift, *Water pollution sources, *Path of pollutants, *Persistence, *Antarctic, Fallout, Winds, Atmospheric physics, Air circulation, Air pollution, Precipitation (Atmospheric).
Identifiers: Pesticide distribution (Geographic).

The discovery of pesticides in Antarctic wildlife has provided a dramatic example of the spread of pesticides. The continent, with its ice shelf, lies over 600 miles from the tip of South America, over 1,000 miles from New Zealand, and over 2,000 miles from the tip of South Africa. Yet despite this isolation, insecticides have been detected in seals, in fish, and in penguins and other birds. Since all the tested animals, with the exception of the skua, feed exclusively in Antarctic waters, the presence of pesticide residues in these animals clearly shows that pesticides have been carried into the Antarctic environment in significant amounts from far distant points of origin. Rain falling on the agriculturally remote Shetland Islands has been found to have about the same level of pesticide concentrations as is found in the San Joaquin River although that river receives drainage directly from irrigated fields. One source of contamination of the atmosphere is pesticide-laden dust picked up directly from soils by storms. The principal mechanism by which the atmosphere cleans itself is rainfall, so that the water-insoluble nature of these pesticides means that they will be removed relatively slowly, permitting their accumulation and world-wide dispersal. (Knapp-USGS)
W70-04585

OIL TAGGING SYSTEM STUDY, Summary.
Melpar, Falls Church, Va.
For primary bibliographic entry see Field 05A.
W70-04655

OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
New York Operations Office (AEC), N. Y. Health and Safety Lab; Lamont-Doherty Geological Observatory, Palisades, N. Y.; Woods Hole Oceanographic Institution, Mass.; and Isotopes, Inc., Westwood, N. J.
H. L. Volchok, M. Feiner, H. J. Simpson, W. S. Broecker, and V. E. Noshkin.
Journal of Geophysical Research, Vol 75, No 6, p 1084-1091, February 20, 1970. 8 p, 2 fig, 4 tab, 31 ref.

Descriptors: *Fallout, *Oregon, *Strontium radioisotopes, Surveys, Sampling, Lakes, Cores, Data collections, Oceans, Pollutants, Precipitation (Atmospheric), Radiochemical analysis, Radioisotopes.
Identifiers: Crater Lake (Oregon), Oceanic fallout.

By the analysis of water and sediment cores, the total inventory of strontium 90 in Crater Lake, Oregon, was determined to be 4.2 curies. In terms of surface fallout, this is equivalent to about 70 mc/sq km. The comparable fallout on the surrounding land area, determined from analyses of soil sections was 58 mc/sq km, and a value predicted by extrapolation from other Oregon stations was 73 mc/sq km. Hence, no substantial difference in the efficiency of fallout collection could be attributed to the mere presence of the large water surface. (Knapp-USGS)
W70-04704

STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
Environmental Science Services Administration, Silver Spring, Md.
L. Machta, K. Telegadas, and D. L. Harris.
Work supported by U S Atomic Energy Comm, and Michigan Univ, Great Lakes Res Div. Journal of Geophysical Research, Vol 75, No 6, p 1092-1096, February 20, 1970. 5 p, 3 fig, 2 tab, 22 ref.

Descriptors: *Fallout, *Lake Michigan, *Strontium radioisotopes, Surveys, Sampling, Lakes, Cores, Data collections, Oceans, Pollutants, Precipitation (Atmospheric), Radiochemical analysis, Radioisotopes.
Identifiers: Oceanic fallout.

Measurements of Sr-90 in Lake Michigan water and sediments indicate that fallout is no greater over the lake than over nearby land. Excess 'oceanic' fallout over land fallout is in controversy. The Lake Michigan result favors no enhancement. (Knapp-USGS)
W70-04705

ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
Marathon Oil Co., Littleton, Colo.; and Scripps Institution of Oceanography, La Jolla, Calif.
William S. Ferguson, John J. Griffin, and Edward D. Goldberg.
Journal of Geophysical Research, Vol 75, No 6, p 1137-1139, February 20, 1970. 3 p, 1 fig, 2 tab, 11 ref. Contract AP 00672-02 HEW.

Descriptors: *Sediment transport, *Air circulation, *Dusts, *Bottom sediments, *Pacific Ocean,

Oceans, Clay minerals, Cores, Sampling, Sedimentation.
Identifiers: Atmospheric dusts.

The clay mineral assemblages in atmospheric dusts from the North Pacific are similar to those of the deep-sea sediments from the same area. These results are in agreement with the concept of an eolian transport of solids from the arid areas of Europe and Asia to the marine environment. (Knapp-USGS)
W70-04707

LEACHING OF POLLUTANTS FROM REFUSE BEDS,
Battelle Memorial Inst., Columbus, Ohio; and West Virginia Univ., Morgantown. Dept. of Civil Engineering.
For primary bibliographic entry see Field 05A.
W70-04714

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.
H. H. Carter.
Chesapeake Bay Institute Technical Report 61, Reference 69-14, Johns Hopkins University, November 1969. 36 p, 18 fig, 14 ref, append. USAEC Contract AT (30-1)-3109.

Descriptors: *Estuaries, *Thermal pollution, *Mixing, Thermal powerplants, Jets, Hydraulic models, Model studies, Hydraulic similitude, Heated water, Dispersion, Diffusion, Path of pollutants, Water temperature, Hydraulics, Hydrodynamics.
Identifiers: Thermal discharges, Jet discharges.

The behavior of a heated discharge of water jetted at right angles into a moving stream of water was studied using a hydraulic model. The discharge orifice is rectangular to simulate a discharge canal and both the jet stream and receiving waters are confined vertically between a free surface (the sea surface), and a solid level boundary (the sea bottom). Experiments were performed in the circulating water flume in the Hydraulics Laboratory at the Chesapeake Bay Institute. The flume has a free surface test section 3 feet wide, 3 ft. 9 in. deep (3 foot water depth) and 16 feet long. The system is capable of producing water velocities of up to 3.2 feet per sec in the test section. For the heated discharge, a model thermal plant was constructed which consisted of a pump, a flow control system, a rotometer, electric immersion heaters to simulate the condensers, and a temperature sensing and control system to maintain a constant temperature rise between intake and discharge. (Knapp-USGS)
W70-04716

URBAN EFFECTS ON QUALITY OF STREAMFLOW,
Texas Univ., Austin. Environmental Health Engineering Research Lab.
For primary bibliographic entry see Field 04C.
W70-04727

HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
Ontario Dept. of Agriculture and Food, Guelph. Provincial Pesticide Residue Testing Lab.
Richard Frank.
Canadian Journal of Plant Science, Vol 49, p 209-215, 1969. 1 fig, 5 tab, 7 ref.

Descriptors: *Herbicides, *Grasses, *Preemergents, *Weeds, Phytotoxicity, Potatoes.
Identifiers: *Indans, Sugar beets, Broadleaved weeds, Preplant treatment, Crabgrass, Greenhouse studies, Growth chamber studies, Field studies.

An appraisal of herbicidal properties of indanyl ethyl ketones was conducted by field, greenhouse, and growth chamber trials. Grasses exhibited varying degrees of susceptibility, but broadleaved weeds proved to be resistant to compounds. Lower temperatures increased phytotoxicity to sugar beets. Preplant and incorporation treatments reduced beet stands more than preemergence treatments. The desired rates of application varied from 1.7 to 3.4 kilogram/hectare. (Wilde-Wisconsin)
W70-04817

YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
Ontario Water Resources Commission, Toronto. Div. of Labs.
J. H. Neil, M. G. Johnson, and G. E. Owen.
Proceedings, Tenth Conference on Great Lakes Research, University of Michigan, Great Lakes Res Div Publication No 15, p 375-381, 1967. 3 fig, 2 tab, 5 ref.

Descriptors: *Watersheds (Basins), *Lake Ontario, *Nitrogen, Phosphorus, Great Lakes, Land use, Sewage effluents, Surface runoff, Regression analysis, Cyanophyta, Water pollution sources, Eutrophication, Phosphates, Nutrients, Lakes.
Identifiers: *Nutrient sources, *Nutrient yields, Urban watersheds, Rural watersheds, Gross yield, Nitrogen rating curve, Nutrient removal, Seasonal variation, Toronto (Ontario), West Humber River (Ont), German Mills Creek (Ont), Little Rouge River (Ont), Stouffville Creek (Ont), Altona Creek (Ont), Highland Creek (Ont).

The nitrogen yield was estimated from six southern Ontario watersheds, representing rural and urban land uses, on the basis of curves for total nitrogen discharge applied to the hydrograph of each watershed. Mean total annual yield of nitrogen (in pounds/square mile per year) was approximately 3,200 for rural streams, and 34,000 for urban watersheds (includes effluents from a secondary treatment plant). Nitrogen (N) yields for February, March, and April, constituted 58-69% of the annual contribution in rural watersheds, while yields from urban watersheds showed little variation and were greater than spring maxima of rural streams throughout the year. Yields calculated from phosphorus (P) concentration in the same samples indicated a nitrogen to phosphorus ratio of 1.5 in urban watersheds and 8.0 for rural watersheds. Under present conditions of sewage treatment in one urban watershed, 28% of P and 22% of N are removed. Complete removal of both nutrients from the sewage would result in 85% reduction of gross yield of phosphate (25% presently being achieved) and 87% reduction in gross yield of nitrogen (20% presently achieved). (Ketelle-Wisconsin)
W70-04979

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
Public Health Service, Cincinatti, Ohio. Div. of Water Supply and Pollution Control.
K. E. Biglane.
Estuaries, Publication No 83, American Association for the Advancement of Science, Wash, D C, p 690-692, 1967. 3 p, 5 ref.

Descriptors: *Water pollution, *Estuaries, *Pesticides, *Louisiana, Fishkill, Watersheds (Basins), Rivers, Dieldrin, Endrin, Chlorinated hydrocarbon pesticides, Coastal marshes, Water quality, Fisheries, Dredging, Navigation, Industrial wastes, Domestic wastes.
Identifiers: *Estuarine pollution, Lower Mississippi Basin, Atchafalaya River.

Toxic synthetic organic chemicals in water appear to be the cause of continuing fishkills in the lower Mississippi drainage basin. Lethal concentrations of endrin, dieldrin and two unidentified chlorinated hydrocarbons were found in dead or dying fish from the Mississippi and Atchafalaya Rivers. Other cases of fishkills due to pollution of the Louisiana Gulf Coast are cited. Louisiana has 422,000 acres of coastal marshes and estuaries which are very productive as fishery, fur, and recreational areas. Oil and other mineral production, shell dredging, industrial and water quality and the physical character of these areas. The preservation of estuarial land masses is important and every effort should be directed toward this goal. (Carstea-USGS).
W70-05006

STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
Argonne National Lab., Ill.
For primary bibliographic entry see Field 08B.
W70-05039

5C. Effects of Pollution

PREDICTING THE EFFECT OF CLEAR-CUTTING ON STREAM TEMPERATURE,
Oregon State Univ., Corvallis. School of Forestry.
For primary bibliographic entry see Field 04C.
W70-04556

STATEMENT OF CONCERN,
Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health.
For primary bibliographic entry see Field 05B.
W70-04584

EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
Rutgers - The State Univ., New Brunswick, N.J.
M. E. Chittenden, Jr., and J. R. Westman.
Available from the Clearinghouse as PB-190 274, $3.00 in paper copy, $0.65 in microfiche. Partial Completion report, Water Resources Research Institute, Rutgers-The State University of New Jersey, Jan 1970. 91 p. OWRR Project B-012-NJ.

Descriptors: *Dissolved oxygen, *Anadromous fish, *Water pollution, Striped bass, Fish.
Identifiers: *Tolerance levels, *Avoidance reactions, *Mortality, *Salinity, Shad.

This is an account of laboratory experiments regarding the vulnerability to some forms of pollution upon young American shad and striped bass, which are anadromous fish passing the estuaries of a number of Eastern rivers. The experiments covered (1)salinity, low temperature, tolerance, and avoidance reactions and oxygen requirements of the shad, (2) effects of Mn (OH)2 settling time on the Winkler dissolved oxygen determination in brackish water, and (3) effect of handling upon the oxygen requirements of the striped bass in fresh and salt waters and (4) oxygen levels at death for the striped bass. (Whipple-Rutgers)
W70-04684

LAKE EUTROPHICATION -- A NATURAL PROCESS,
Geological Survey, Albany, N.Y.
Phillip E. Greeson.
Water Resources Bulletin, Vol 5, No 4, p 16-30, December 1969. 15 p, 6 fig, 2 tab, 44 ref.

Descriptors: *Eutrophication, *Lakes, Nutrients, Water pollution effects, Productivity, Sediments, Urbanization, Water pollution treatment, Algae, Water management (Applied), Limnology.
Identifiers: Eutrophication treatment.

Lake eutrophication is an economic, recreational, and aesthetic problem that affects every lake of the world. Eutrophication is the natural process of lake aging, and progresses irrespective of man's activities. Pollution, however, can hasten the natural rate of aging and shorten the life expectancy of a body of water. The eutrophication of a lake consists of the gradual progression from one life stage to another based on the degree of nourishment or productivity. The extinction of a lake is attributed

to enrichment by nutritive materials, biological productivity, decay, and sedimentation. Presently used methods for retarding eutrophication are the abatement of cultural enrichment, treatment of eutrophic symptoms, and control of fundamental causes. (Knapp-USGS)
W70-04721

THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
Royal Danish School of Pharmacy, Copenhagen. Dept. of Botany.
For primary bibliographic entry see Field 02H.
W70-04809

EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
Schoell and Madson, Inc., Hopkins, Minn.
For primary bibliographic entry see Field 02H.
W70-04810

DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
Marine Lab., Aberdeen (Scotland); and Indiana Univ., Indianapolis. Dept. of Microbiology.
A. L. S. Munro, and T. D. Brock.
Journal General Microbiology, Vol 51, p 35-42, 1968. 3 fig, 1 tab, 14 ref, 3 plates.

Descriptors: *Aquatic bacteria, *Algae, *Analytical techniques, *Marine microorganisms, Physiological ecology, Organic matter, Water pollution effects, Diatoms, Carbon radioisotopes, Kinetics, Tritium, Chlorophyll.
Identifiers: *Heterotrophy, *Organic solutes, *Marine environments, Microbial ecology, Fluorescence microscopy, Acetate, Carbon-14, Autoradiography, Michaelis-Menten equation, Loch Ewe (Scotland), Scotland, Phaeopigments, Acridine orange, Lineweaver-Burke equation.

Staining with acridine orange and direct observation with fluorescence microscopy demonstrates numerous viable bacteria and diatoms attached to sand grains of a littoral beach to depths exceeding 10 centimeters. Kinetic analysis of uptake of radiocarbon-labelled acetate over range, 10-5000 micrograms/liter, demonstrates two uptake mechanisms: one, saturable at lower concentrations (Michaelis-Menten kinetics), and another, describable as diffusion, the latter having been attributed by others to algal uptake. Autoradiography, however, reveals that bacteria alone are responsible for uptake of tritiated acetate. In those situations where Michaelis-Menten kinetics applied, maximum attainable uptake rates (V) were much greater than any previously reported for water, such values for V being attributable to larger microbial populations in sand. Since reasons for existence of two types of kinetics are obscure, it is dangerous to make conclusions regarding microbial heterotrophy based on kinetic analysis alone. Based on these studies, it seems clear that algal heterotrophy is negligible in sea waters, and that autoradiography is an effective tool in studies of energetics and trophic relationships in microbial ecology. (Eichhorn-Wisconsin)
W70-04811

VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
California Univ., San Diego, La Jolla. Inst. of Marine Resources.
Alan R. Longhurst.
Deep-Sea Research, Vol 14, p 51-63, 1967. 3 fig, 3 tab, 22 ref.

Descriptors: *Zooplankton, *Vertical migration, *Sampling, Biomass, Anaerobic conditions, Coasts, Diatoms.
Identifiers: *Vertical distribution, *Plankton sampler, Nocturnal migration, Coastal upwelling, California Current, Baja California, Calanus helgolandicus.

The use of a new plankton sampler assisted to evaluate the presence of a dense population of Calanus helgolandicus and other plankters below 150 meters in the southern part of the California Current in oxygen-deficient water (0.2 milligrams/liter of oxygen). Several species of this deoxygenated zone perform nocturnal migrations to upper strata with oxygen tension up to 5.0 milligrams/liter. The unusual abundance of the fauna in the deoxygenated layer is attributed to the effects of the local coastal upwelling followed by rapid diatom blooms along the coast of California peninsula. (Wilde-Wisconsin)
W70-04815

SEASONAL AND VERTICAL DISTRIBUTION OF THE ZOOPLANKTON IN THE ASKO AREA (NORTHERN BALTIC PROPER) IN RELATION TO HYDROGRAPHICAL CONDITIONS,
Stockholm Univ. (Sweden). Dept. of Zoology; and Stockholm Univ. (Sweden). Asko Lab.
Hans Ackefors.
Oikos, Vol 20, No 2, p 480-492, 1969. 13 fig, 14 ref.

Descriptors: *Zooplankton, *Seasonal, Temperature, Light, Salinity, Vertical migration.
Identifiers: Vertical distribution, Asko area (Baltic Sea), Synchaeta, Podon polyphemoides, Acartia bifilosa, Eurytemora.

Sampling of zooplankton in intervals of 2.5 meters to 36 meters depth revealed seasonal and vertical distribution of rotifers, cladocerans, copepods, and other plankters. The maximum density of organisms of 650 specimens per 23 liters was observed from the end of July to the middle of September. Synchaeta spp attained the greatest density from July until part of September, whereas Podon polyphemoides was largely confined to 15 meters depth in July and August. Acartia bifilosa was present at all depths to 35 meters and was especially abundant in September, December, and March. Eurytemora spp were evenly distributed from bottom to the surface and attained maximum density in summer and fall. Salinity varied from 0.62 to 0.70% at the surface, and from 0.67 to 0.78% at the bottom. (Wilde-Wisconsin)
W70-04816

INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
Hull Unov. (England). Dept. of Botany.
For primary bibliographic entry see Field 02H.
W70-04818

MANAGING THE GREAT LAKES WATER RESOURCE,
North Carolina Univ., Chapel Hill. School of Public Health.
For primary bibliographic entry see Field 06B.
W70-04848

PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
North Dakota State Univ., Fargo. Div. of Natural Sciences.
For primary bibliographic entry see Field 02H.
W70-04855

TO PREVENT AN UNNATURAL DEATH.
Open Lands Project, Chicago, Ill.

Summary of Proceedings of Four-State Lake Michigan Conference, Chicago, Illinois, April 1969. 30 p.

Descriptors: *Lake Michigan, Illinois, Indiana, Wisconsin, Michigan, Thermal pollution, Industrial wastes, Sewage treatment, Landfills, Chemical wastes.

The threats to Lake Michigan are seen as: (1) thermal pollution; (2) sewage and industrial wastes; (3) agricultural chemicals; (4) landfill; and (5) unplanned shoreline development. Statements from various advocacy groups from the four states participating give indication of strong citizen concern about the deterioration of Lake Michigan waters. All participants agreed upon viewing Lake Michigan in a holistic manner so as to consider all the implications of the intra and inter-relationships peculiar to the lake. Recommendations from the Conference included a proposal that a major effort be directed to total planning for the lake in order to detect quickly ecological imbalances which occur so that they can be remedied before they become irreversible. (Starr-Chicago)
W70-04898

PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor.
Eugene F. Stoermer, and J. J. Yang.
University of Michigan, Ann Arbor, Great Lakes Research Division, Special Report No. 47, 1969. 268 p, 65 ref.

Descriptors: Phytoplankton, *Diatoms, Lake Michigan, Eutrophication.
Identifiers: Diversity index, *Thermal bar.

Detailed analyses are presented of plankton diatom populations occurring in modern collections from all parts of the lake as well as collections from the Chicago area dating back to 1876. Records of occurrence and population frequency are given for 714 taxonomic entities. Diversity and redundancy indices were calculated for the assemblages examined. Study showed increasing incursion of pollution tolerant forms into the Lake Michigan flora. Species which have caused objectional blooms in recent years in southern Lake Michigan first occurred in collections taken in the 1930's and now are found in all parts of the lake. Species associated with extreme water quality degradation in Lake Erie have recently been introduced into Lake Michigan. At the present time extreme differences are noted between the nearshore flora and that of the open lake, particularly during thermal bar conditions in the spring. On the basis of floristic analysis the author's general conclusion is that Lake Michigan at the present time is approaching the break-point between transient algal nusiances confined to the inshore area and more drastic changes affecting the entire ecosystem.
W70-04902

5D. Waste Treatment Processes

PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
IIT Research Inst., Chicago.
Layton C. Kinney, and Victor R. Ivanuski.
Available from the Clearinghouse as PB-190 169, $3.00 in paper copy, $0.65 in microfiche. Robert A. Taft Water Research Center Report No TWRC-13, Federal Water Pollution Control Administration, October 1969. 46 p, 13 fig, 11 tab, 10 ref, 1 append. FWPCA Project 17050---10/69, Contract No 14-12-433.

Descriptors: *Pollution abatement, *Water pollution control, *Sewage, Industrial wastes, Domestic wastes, Organic matter, Irradiation, Titanium, Sands, Streams, Lakes.
Identifiers: *Photolysis, *Photocatalysts, Photocatalytic oxidation.

Photocatalytic oxidation of dissolved organic matter by irradiation of slurries of zinc titanate, zinc oxide, titanium dioxide, and beach sand was studied using sunlamps. The reaction appears to follow first order kinetics in most cases. Zinc oxide

appears to be a superior catalyst for this purpose. Photocatalysts are widely distributed in nature, and photolytic oxidation is a mechanism whereby dissolved organic matter is oxidized in the natural environments of streams and lakes. Photolytic oxidation reduced the dissolved organic matter in a sample of domestic sewage by 50% and 75% during 24 hours and 70 hours, respectively. The limiting factor appears to be the activity of the photocatalyst. The most promising area of photolysis application will be in problems of industrial disposal where the concentrations of organic matter are high. (Carstea-USGS)
W70-04546

MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
General American Transportation Corp., Niles, Ill.
General American Research Div.
L. Seiden, and K. Patel.
Available from the Clearinghouse as PB-190 170, $3.00 in paper copy, $0.65 in microfiche. Robert A. Taft Water Research Center Report No TWRC-14, Federal Water Pollution Control Administration, September 1969. 69 p, 10 fig, 5 tab, 152 ref, 3 append. FWPCA Project 17010---9/69, Contract No 14-12-416.

Descriptors: *Mathematical models, *Tertiary treatment, *Lime, *Phosphorus compounds, *Computer programs, Effluents, Acidity, Cost analysis, Streams, Streamflow, Flow rates, Coagulation.
Identifiers: Secondary effluents, *Phosphorus removal.

The status of phosphorus removal from secondary effluents by lime addition is presented. Based on the empirical information available, a mathematical model of the process was developed. The factor which best correlated with phosphorus removal was the pH of the tertiary effluent. Cost information for the model was generated based on a solids-contact type precipitator such as the Infilco Densator. A computer program, in FORTRAN IV, derived from the model, was developed for use as a subroutine in the FWPCA Executive Calling Program. Given the input stream flow rate and analyses, and the final pH, the program computes the necessary doses of lime and coagulant, their costs, the size and cost of the equipment, the degree of phosphorus removal, and the output stream analyses. (Carstea-USGS)
W70-04547

APPRAISAL OF GRANULAR CARBON CONTACTING: PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
Swindell-Dressler Co., Pittsburgh, Pa.
A. E. Cover, and L. J. Pieroni.
Available from the Clearinghouse as PB-190 168, $3.00 in paper copy, $0.65 in microfiche. Robert A. Taft Water Research Center Report No TWRC-11, Federal Water Pollution Control Administration, May 1969. 109 p, 33 fig, 21 tab, 58 ref. FWPCA Project 17020---5/69, Contract No 14-12-105.

Descriptors: *Reviews, *Waste water treatment, *Activated carbon, Tertiary treatment, Organic matter, Wastes, Chemical oxygen demand, Particle size, Economics, Costs, Flow, Adsorption, Bibliographies, Surveys.
Identifiers: Granular carbon filters.

A literature review of tertiary waste water treatment gives special attention to activated carbon adsorption of chemical oxygen demand (COD), allowable capacity (loading) of carbon with organic waste matter, carbon particle size, and number of regeneration cycles on adsorption capacity and rate. The economic effects of shop fabrication and field erection of vessels, surge designs, plant size, idle carbon inventory, velocity, contact time, particle size, regeneration loss, carbon capacity, material costs, number of contacting stages, and in-place regeneration are discussed. Most of the data were collected from carbon treatment plants at Pomona (California), Lake Tahoe (California), Nitro (West Virginia), Washington (New Jersey), and Lebanon (Ohio). Recommendations are made for further evaluation and experimental work. (Carstea-USGS)
W70-04548

APPRAISAL OF GRANULAR CARBON CONTACTING: PHASE 3. ENGINEERING DESIGN,
Swindell-Dressler Co., Pittsburgh, Pa.
A. E. Cover, and C. D. Wood.
Available from the Clearinghouse as PB-190 167, $3.00 in paper copy, $0.65 in microfiche. Robert A. Taft Water Research Center Report No TWRC-12, Federal Water Pollution Control Administration, May 1969. 40 p, 4 fig, 1 tab, 5 ref, 3 append. FWPCA Project 17020---5/69, Contract No 14-12-105.

Descriptors: *Cost analysis, *Activated carbon, *Tertiary treatment, *Design criteria, Waste water treatment, Economics, Engineering structures, Equipment.
Identifiers: *Granular carbon.

The engineering design and cost estimate of a 10 million-gallon-per-day plant for tertiary treatment of waste water with granular activated carbon contains the process description, design bases, plant operation, control rationale, equipment list, equipment specifications and cost estimate. This design incorporates reliability, economy and current state-of-the-art technology. Although not fully proven in practice, it is based upon the application of mature engineering judgement to available data and offers economies over any other plant which has been successfully demonstrated. (Carstea-USGS)
W70-04549

CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
J. A. McCarthy.
Sanitalk, Vol. 1, p 8-11, 1952.

Descriptors: *Test procedures, *Trickling filters, *Waste water treatment, Coagulation, Sedimentation, Lagoons, Biochemical oxygen demand.
Identifiers: *Wool dyeing wastes, *Color removal, Dyeing wastes, Vat dyeing waste, Filter loading, Top dyeing waste.

This report studied the use of experimental trickling filters for treating the two types of wool dyeing wastes. The top dyeing waste contains little suspended matter and much of the BOD is in solution. Ordinary coagulates are generally ineffective and even prolonged sedimentation gives little improvement. Storage in lagoons may result in some reduction in color, but little reduction in BOD. With standard trickling filters it was found that loadings of 1000 to 1500 pounds of BOD per acre foot resulted in a BOD reduction of 90%. Recirculating the wastes through the filters with a ratio of 5 to 1 showed that BOD loading could be gradually increased to 5000 lbs./acres ft. with an 89% reduction in BOD. Vat dyeing wastes while lower in BOD, required a reduction in filter loading to 1000 lbs. of BOD per acre foot in order to obtain a 90% reduction. Recirculation of this waste through the filters increased the loading only 30 to 40 percent. As both types of dye wastes are customarily found in the same mill combing these two wastes gave satisfactory effluent through trickling filters with loadings of 1200 lbs. of BOD per acre foot. (Livengood and Mattox - North Carolina State University)
W70-04586

RIVER POLLUTION IN INDUSTRIAL AREAS: AN INSOLUABLE PROBLEM,
L. Klein.
Institute of Sewage Purification Journal and Proceedings, p 503 511, 1961. 16 ref.
Identifiers: *Turbine aeration.

Special difficulties facing river boards in highly industrial areas of England, Wales, and Scotland are: (1) multiple pollution in small river, (2) inadequate dilution water, (3) intractable nature of certain trade effluents, and (4) high cost of purifying sewage and trade effluents. Possible ways of improving rivers in these areas are (1) stricter standards for sewage effluents, (2) improved setting for sewer storm overflows, (3) discharge of trade effluents to sewers, (4) use of clean water to dilute effluents, (5) treatment of river water. Turbine aeration is a practical method of increasing the dissolved oxygen content of river water passing through hydroelectric installations. The Swedes increase dissolved oxygen content by bubbling compressed air into water through a perforated plastic tube. Perhaps the most satisfactory method of dealing with a grossly polluted river is a complete treatment plant containing settling equipment and an activated sludge process. (Robinson - North Carolina State University)
W70-04587

EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
Bolton and District Joint Sewage Board.
Peter Brown.
Institute of Sewage Purification Journal and Proceedings Part 3, p 267-271, 1963.

Descriptors: *Activated sludge, *Biochemical oxygen demand, Waste water treatment.
Identifiers: *Finishing wastes, Starch.

The investigation is confined to a laboratory scale-activated sludge process. If the waste contained very little else but starchy products, the permanganate value and BOD drop to the level of the control sample after a short period of further aeration. The experiment on trade effluent containing starchy material seems to indicate that a higher initial BOD loading was not necessarily the cause of extra residuals in the effluents. Certain trade effluents contribute residual impurities to a sewage works' final effluent. Under test conditions, residuals increase the permangate value of the effluent to a greater extent than the BOD. The presence of residuals should be a major consideration when deciding whether a trade effluent can be accepted for treatment at a sewage works. (Robinson - North Carolina State University)
W70-04588

ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
Resources for the Future, Inc., Washington, D.C.
For primary bibliographic entry see Field 04B.
W70-04614

TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
Trent River Board (Gt. Brit.).
D. Evers.
Textile Institute and Industry, Vol. 3, p237-240, 1966.

Descriptors: *Water pollution, *Biochemical Oxygen Demand.
Identifiers: *Wool scouring, *Carpets, Dyeing, Sizing, Latices, Moth-proofing, Mildew resistance treatments, Sulfuric acid, Caustic, Heat pollution, Wool grease, Wool.

The processes causing water pollution are (1) scouring of wool, (2) dyeing, (3) sizing the carpet backing, (4) latexing, and (5) moth and mildew proofing. Scouring of wool is by far the worst source of pollution, but this can be materially reduced by (1) acid cracking with sulfuric acid or (2) by the use of calcium chloride. Either allows much of the wool grease and other impurities to be removed as solids from the effluent water obtained from scouring. Four tables present numerical data. Dyehouse effluents may have pH values as low as 2 and require alkaline treatment, but they are also

very hot and may require cooling lest they cause overheating in the sewage disposal plant. The back sizing with starch or glue is a minor source of water pollution. Latexing effluents may be treated with acid to precipitate the latex and whiting. Moth and mildew proofing may result in acid which can be neutralized or fluorides, which if excessive, can be precipitated with a barium compound. It is concluded that effluents from carpet mills must be individually studied and each handled as a separate problem. (Work-North Carolina State Univ)
W70-04625

TREATMENT OF WOOL WASTES,
Purdue Univ., Lafayette, Ind. Engineering Extension.
A. M. Buswell, and H. F. Mueller.
Proceedings of the Eleventh Industrial Waste Conference, Series No. 91, p.160-165, 1956.

Descriptors: *Anaerobic digestion.
Identifiers: *Wool, *Wool grease, Lanolin, Experimentation.

In the scouring of raw wool with soap and alkali to remove foreign matter, the waste waters have an extremely high BOD and are very polluting. The usual method of treatment involves addition of H2SO4 and sedimentation to remove grease and sludge, but the sedimentation tank effluent still requires dilution before discharge to the sewers. Wool grease consists of the suint and fat (largely lanolin). Experiments were made on raw wool wherein it was submitted to anaerobic fermentation. Most of the grease and other organic contaminants, other than lanolin, were decomposed and the wool fibers were unharmed. Sand and solids settled. Potash can be concentrated. No large scale trials are reported. (Work-North Carolina State Univ)
W70-04626

SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
Purdue Univ., Lafayette, Ind.
C. S. Carrique, and L. U. Jauregui.
Proceedings of the 21st Industrial Waste Conference, Engineering Extension Series No. 1212, Vol. 50, Part 2, p861-868, 1966.

Descriptors: Costs.
Identifiers: *Textile mill wastes, *Caustic, Mercerizing, Cotton fabrics.

Because of the high cost of caustic in Argentina, it is recovered from the operations of a textile mill processing 2,000 metric tons of cotton per year. The caustic is mainly used in the mercerizing process. The caustic solution is filtered, concentrated in a two-stage evaporator, and refiltered for reuse. A saving of about $20,000 (U.S.) per year is achieved and water pollution is prevented. (Work-North Carolina State Univ)
W70-04637

THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
California Univ., Riverside. Dept. of Economics.
Paul B. Downing.
Available from Frederick A. Praeger, Publishers, 111 Fourth Avenue, N.Y., N.Y. 10003, for $15 per copy. New York: Frederick A. Praeger, Publishers, 1969. 196 p, 38 tab, 13 fig, 58 ref, 1 append.

Descriptors: *Evaluation, *Cost-benefit analysis, *Sewage disposal, Sewers, Cost comparisons, Costs, Cost analysis, Estimated costs, Estimated benefits, Wastewater disposal, Domestic wastes, Municipal wastes, Marginal costs.
Identifiers: Wastewater treatment costs, Wastewater collection costs, Garbage grinders, Effluent charges.

Cost-benefit analyses were applied to the collection and treatment of urban sewage (excluding storm water runoff) with the following results: (1) The cost per capita per million gallons per day of volume for collection, transmitting, and treating sewage declined as the number of people served increased. (2) A net savings of $1.55 per person yearly would accrue to a municipality if individual garbage grinders were used in lieu of garbage collection. (3) To assess the cost of the variation in flow in a fixed-capacity treatment plant, the cost of increasing the sewer capacity reserved for each individual by 25 gallons per day was estimated to be 3 cents per capita per year per mile of sewer. (4) If a plant serving 100,000 people were increased in capacity to treat the expected hourly peak flow at 90 percent, the cost of treatment would increase from $2.07 to $3.48 per capita per year. (5) Treatment facilities should be expanded to service urban 'fringe' areas, if soil conditions are poor and if there is a net external cost to the septic tank system. (6) The marginal cost of serving an increase in urban population density was estimated to be 64 cents per capita per year. (7) For a hypothetical urban complex of 102,400 people, with varying population densities, one treatment plant was always cheaper than two plants. (8) A city of 10,000 would have to be less than ten miles from the edge of a city of 100,000 before it would be economical to send the small city's sewage to the large city's plant. (9) Large savings in pollution damage would be necessary before a regional treatment plant would be economically feasible. (10) The effluent charge system for waste discharge should be adopted to enhance the 'stream standard' for water quality. (11) Three special charges to aid financing of urban sewage facilities were suggested: (a) A special adjustment of rates to allow for differences in sewage strength for large industrial customers, (b) A higher peak load price for large customers who release widely varying loads, and (c) A special charge for customers who do not install a garbage grinder.
W70-04648

DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
Robert A. Taft Water Research Center, Cincinnati, Ohio. Advanced Waste Treatment Research Lab.
Frank C. Gunderloy, Jr., Cliff Y. Fujikawa, V. H. Dayan, and S. Gird.
Available from the Clearinghouse as PB-190 195, $3.00 in paper copy, $0.65 in microfiche. Federal Water Pollution Control Administration, Cincinnati, Ohio, Robert A. Taft Water Research Center Report No. TWRC-1, Oct, 1968. 67 p, 14 tab, 232 ref, 1 append. FWPCA Project 17010---10/68, Contract No. 14-12-52.

Descriptors: *Nitrates, Wastewater treatment, *Denitrification, Catalysis, Bibliographies, *Reduction (Chemical), *Water reuse, Chemical reactions.
Identifiers: Ferrousion, Cupric ion.

A new and unexpected partial denitrification of dilute nitrate ion solutions (10 to 50 ppm NO3-N) has been achieved by treatment with 8 moles of ferrous sulfate per mole of nitrate in unbuffered alkaline reactions. The nitrogen loss, which probably represents evolution of N2 or N2O, has been as high as 50%. Total reduction to lost nitrogen plus nitrite and/or ammonia has approached 100%. The reduction takes place in the presence of partially oxidized black iron hydroxides, and requires catalytic quantities of cupric ion. Denitrification is suppressed by phosphates, as well as by several other factors, some as yet unidentified. Silver ion catalysis or a 16-fold excess of the ferrous salt permits reduction to ammonia in the presence of phosphate, but there is no accompanying denitrification. A literature survey resulted in the selection of 232 references.
W70-04652

PROBABILISTIC VARIATIONS IN ULTIMATE FIRST STAGE BOD,
Illinois State Water Survey, Peoria. Water Quality Section.
Veerasamy Kothandaraman.
ASCE Proceedings, Journal Sanitary Engineering Division, Vol 96, No SA1, Paper 7054, p 27-34, February 1970. 8 p, 3 fig, 1 tab, 9 ref, append.

Descriptors: *Biochemical oxygen demand, *Biochemistry, Oxidation, Oxygen sag, Dissolved oxygen, Probability, Sewage treatment, Water pollution effects, Statistical methods, Statistical models.
Identifiers: Biochemical reaction rates.

Variations in the ultimate first stage BOD are found to be lognormally distributed under the hypothesis that the bacterial oxidation of organic matter is a first order reaction, and that the deoxygenation coefficient is normally distributed with known parameter values of mean and variance. In the exponential decay curve for the ultimate first stage BOD, the variance in predicting ultimate BOD increases with increase in time. Expressions for the mean, variance, and modal values of the ultimate first stage BOD are presented. (Knapp-USGS)
W70-04711

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
Herman Bouwer.
ASCE Proceedings, Journal Sanitary Engineering Division, Vol 95, No SA1, Paper 7096, p 59-74, February 1970. 16 p, 10 fig, 1 tab, 20 ref.

Descriptors: *Artificial recharge, *Water spreading, *Water reuse, *Tertiary treatment, Infiltration, Filtration, Sewage treatment, Sewage disposal, Hydrogeology, Groundwater movement, Water resources development, Reclaimed water.
Identifiers: Phoenix (Ariz), Salt River (Ariz).

Soil and hydrogeologic conditions permitting, groundwater recharge by surface spreading is an economic and esthetic way for further treatment or renovation of secondary sewage effluent, cannery wastes, or similar low-quality water. The design of a system of spreading areas with wells or drains for collecting the reclaimed water should generally be based on: (1) A maximum limit for the elevation of the water table mound beneath the spreading areas; (2) a minimum limit for the underground detention time and travel distance as the water moves to the wells or drains; and (3) minimum contamination of the groundwater in the aquifer outside the recharge system. Hydraulic properties of aquifers, including anisotropy, can be determined by analog and by field measurements. These data are used to evaluate the effective transmissibility for recharge, and to calculate water-table positions and underground detention times for a system of long, parallel spreading strips with wells midway between the strips. (Knapp-USGS)
W70-04712

A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
Lawrence Experiment Station, Mass.
J. A. McCarthy.
Sanitalk, Vol. 3, No. 3, p17-18, 1955.

Descriptors: *Waste water treatment, *Coagulation, Test procedures, Hydrogen ion concentration, Recirculated water, Calcium chloride.
Identifiers: *Wool grease recovery, *Biological filtration, *Scouring waste, Liquor treatment, Wool scouring liquors, Recirculating filters.

Studies on the treatment of wool scouring waste waters made by the Lawrence Experiment Station, Massachusetts, have shown that coagulation with CaCl2, usually 2% by weight, with the introduction of live steam with adjustment of pH value gives up to 98% reduction in concentration of grease and 66% reduction in BOD. The treated waste waters still contain about 500-800 ppm grease and have a BOD of 4000-7000 ppm. To assess the permissible loading and probably removal of BOD in treatment of the waste waters by biological filtration, several series of filters were operated, the liquor being ap-

plied in a mixture with rinsing waters which are usually available in volumes 3 to 10 times greater than those of scouring waste waters and have a relatively low BOD and grease content. The loading applied to the filters was usually 2000 lbs/acre-ft. and the proportion of liquor to rinsing waters applied to two recirculating filters in series varied from 25% to 10% scouring liquor, the corresponding reduction in BOD of the mixture increasing from 60 to 83%. The grease content was reduced by 90%. These results indicate that wool scouring liquors with a BOD of 16,000 before coagulation can be treated by two-stage biological filtration after dilution with 90% rinsing waters. (Livengood-Mattox-North Carolina State Univ)
W70-04743

ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
Texas Univ., Austin.

Edited by Earnest F. Gloyna and W. Wesley Eckenfelder, Jr. Austin, Texas, University of Texas Press, 1968. 513 p.

Descriptors: *Waste disposal, *Wastewater treatment, *Streams, *Rivers, *Biological treatment, *Industrial wastes, *Pollution abatement, Ecology, Biological properties, Anaerobic digestion, Flocculation, Filtration, Surfactants, Eutrophication, Lakes, Saline water.
Identifiers: *Waste stabilization ponds, *Biological oxidation, *Anaerobic treatment, Activated sludge plants, Aerated lagoons, Mathematical modeling of mixing.

Text consists of a series of 38 special lectures presenting current practices and advances in wastewater analysis, treatment and disposal. The text reflects its stated objective of demonstrating that wastewater management encompasses virtually every water resource activity. Section One of the book discusses the broader aspects of water resources conservation, the transport and dispersion of wastes in streams and the ecology of aquatic environments. The special lectures indicate the many facets of these factors which involve problems in economics, management, hydraulics, stream ecology, and mathematical modeling of various mixing phenomenon. Section Two contains lectures which examine and explain current specific concepts and theories in advanced biological waste treatment, including illustrations of the most recent improvements in process design. Section Three discusses current trends and advances in: (1) low-cost treatment practices, (2) use of waste stabilization ponds for biological treatment of wastewater containing organic pollutants, (3) development of design criteria and relevant significant innovations. (See also W70-04762 thru W70-04794). (D'Arezzo-Texas)
W70-04761

WATER RESOURCES VALUES,
Resources for the Future, Inc., Washington, D.C.
Allen V. Kneese.
Advances in Water Quality Improvement, (Editors: E. F. Gloyna and W. W. Eckenfelder, Jr), Austin, Texas, Univ of Texas Press, 1968, p 3-8, 3 ref.

Descriptors: *Cost-benefit analysis, *Cost comparisons, *Industrial water, *Municipal water, *Value, *Waste treatment, Water quality, Water resources, Pollutants, Cost analysis, Municipal wastes, Dissolved oxygen, Management.
Identifiers: *Economic and system analysis, *Regional systems approach, *Low-quality water treatment, ORSANCO, INCODEL, Delaware River estuary, Clean Rivers Restoration Act, Hudson River, Rhine River, Philadelphia.

A discussion of water resources values is presented stemming from the basic premise that the net value of water quality in water courses is a function of both the benefits resulting from improved water quality versus costs of attaining the specified quality. Author finds that while progress has been made in pollution control, serious problems continue, notably the problem of residuals in treated municipal wastes and control of industrial waste. The regional systems approach is suggested for the solution of the water pollution problems. Conclusions are reached that both costs and gains of quality improvement must be considered in determining the maximum net value of rivers. Finally, it is contended that scientific and engineering developments can be applied rationally and systematically provided their economic and institutional impacts also are understood and considered in the evaluation process. As illustration, municipal waste treatment costs double when waste removal from effluent is increased from 90% to 96-97%. Costs triple in increasing removals from 97% to 100%. Also cited are the cost implications of various alternatives regarding increased dissolved oxygen states in the Delaware River estuary. (See W70-04761). (D-'Arezzo-Texas)
W70-04762

ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
Illinois Univ., Urbana.
John H. Austin, and R. S. Englebrecht.
Advances in Water Quality Improvement, (Editors: E. F. Gloyna and W. W. Eckenfelder, Jr.), Austin, Texas, Univ of Texas Press, 1968, p 9-20, 7 fig, 3 tab, 23 ref.

Descriptors: *Ecology, *Nutrients, *Dissolved oxygen, *Bacteriophage, *Viruses, *Biological communities, Biological treatment, Chemical analysis, Temperature, Oxygen demand, Velocity, Waste treatment, Wastewater treatment, Benthos.
Identifiers: *Long-term ecological changes, *Flow factors, *Persistence of bacteria, Nematode concentration, Salmonellae, Benthic community, Nutritional groups.

The discussion ensues from two basic questions: (1) How might the information available today be used to predict the effect of waste on a given stream. (2) If the knowledge available today is inadequate, what additional information is needed. The authors suggest that the study of ecological changes in a polluted aquatic environment is an experiment in the inter-relationships of the scientific disciplines involved. Thus, the individual efforts of chemists, biologists, engineers, and others are presented to demonstrate the durability of correlated efforts to understand the ecological changes in a polluted environment. For example, biochemical process of oxygen utilization may be controlled in part by a physical process such as the stream velocity in which the organism lives. The coliform titer of a stream may be greater when receiving a chlorinated wastewater effluent than an unchlorinated (but otherwise comparable) effluent. Conventional bacteriological indicators of pollution may be misleading insofar as viral contents are concerned. Only by detailed analysis of the many-faceted ecological picture can some of the complicated problems of the polluted environment be solved. (See W70-04761). (D'Arezzo-Texas)
W70-04763

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
Karl Wuhrmann.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F. and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 21-48, 11 fig, 8 tab, 35 ref.

Descriptors: *Activated sludge, *Costs, *Cost comparisons, *Denitrification, *Phosphorous compounds, *Nitrogen compounds, *Sewage, *Biological treatment, Design, Phosphates, Concentration, Temperature, Lime, Iron Pollutants.
Identifiers: *Endogenous denitrification, *Post-precipitation, *Sludge loads, *Sedimentation curve, *Precipitation unit, Nutrient removal, Anaerobic plants, Final effluent, Settled sewage, pH, Iron (III).

Discussed are the objectives of nutrient removal processes, the types and amounts of nutrients to be removed and the perspective success of tertiary treatment. Paper analyzes procedures for the elimination of phosphorus from sewage, including a thorough explanation of iron (III) as a precipitant, phosphorus elimination using lime and, phosphorus removal using both lime and iron (III). The removal of nitrogen compounds from sewage is discussed from the viewpoints of general process layout, the process of nitrification in activated sludge treatment, denitrification by activated sludge, the role of oxygen as a limiting factor, the respiration substrates as limiting factors and results of practical experiments with denitrification conducted at a pilot plant station. Discussed are certain cost-justifiable, beneficial side effects of nitrogen and phosphorus removal processes. Also presented are detailed estimates of annual and net operation costs and design factors for phosphorus and nitrogen removal plants. Conclusions are reached that the conventional biological treatment will still represent the basis of all further purification steps, both for economic and process reasons. Further, past scientific and monetary investment in sewage purification will not lose its value, not even in view of eventual totally new procedures generated by demands for much higher, sewage effluent qualities. (See W70-04761). (D'Arezzo-Texas)
W70-04764

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION: PROBLEMS IN FRESHWATER,
Texas Univ., Austin.
E. Gus Fruh.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F. and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 49-64, 7 tab, 82 ref.

Descriptors: *Eutrophication, *Nitrogen compounds, *Phosphorus compounds, *Nutrients, *Bioassay, *Runoff, *Lakes, *Impoundments, Tertiary treatment, Algae, Domestic wastes.
Identifiers: *Micronutrients, *Nutrient interactions, *Radiocarbon bioassay, *Nutrient types, Microquantities, Macroquantities, Algal blooms, Liebig's Law of the Minimum, Voisin's Law of the Maximum.

The purpose of the presentation is to provide a framework of reference on the eutrophication problems of freshwater. Important insights on eutrophication have come from the fields of botany, limnology, and sanitary engineering. Discussed are the types and impacts of critical nutrients. Special attention is focused on nitrogen, and phosphorus, including a detailed discussion of specific sources, namely rainfall, groundwater, forest runoff, agricultural runoff, urban drainage and wastewater effluents. Analysis is made of the relationship of nuisance conditions to nitrogen and phosphorus. Examination is made of the role of organic and inorganic micronutrients; the nature of nutrient interactions with various physical, chemical, and biological variables. Various approaches to control eutrophication are reported. Conclusions are reached that other than tertiary treatment, diversion of the nutrient-rich sources appears the most feasible eutrophication control. However, leaching or bacterial decomposition of nutrients from the sediments seems the limiting factor in lake recovery rates. Many processes in aquatic environments are attributed to bacteria, however, current analytical techniques are inadequate for the quantitative evaluation of bacterial species and number. (See W70-04761). (D'Arezzo-Texas)
W70-04765

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION: SALINE WATER CONSIDERATIONS,
Texas Univ., Port Aransas. Inst. of Marine Science.
B. J. Copeland, and Donald E. Wohlschlag.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F. and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 65-82, 8 fig, 2 tab, 41 ref.

Descriptors: *Zooplankton, *Ecosystems, *Marine microorganisms, *Sewage, *Wastewaters, *Photosynthesis, Nutrients, Phosphorus, Organic loading.
Identifiers: *Texas coast, *Species diversity, *Metabolic rates, Oil field brine-bleedwater, Petrochemical industry wastewaters, Seafood packing wastewaters, Pulp mill wastes.

This presentation examines and describes the major effects of the many nutrient-laden effluents on the estuaries, bays and lagoons along the Texas coast. It is found that the addition of a known nutrient source to a marine community resulted in changing ecosystem metabolic patterns. Increase in nutrient caused an increase in photosynthetic production. Species diversity of zooplankton is reduced in marine environments receiving some types of organic wastes indicating community disruption can result by new nutrient influxes. Toxic effects are not always detectable by conventional measurement methods. With a slight increase in mortality rate, the fish biomass affected would be decreased greatly. Experiments on fish metabolic rates showed that slight pollution stresses lower the metabolic rates greatly. The lowering was maximal when the fish were already subjected to an initial environmental stress, such as low temperature. Most of the effects of waste effluents on marine environments are subtle. It is believed that analyses based on the community rather than on the organismic approach are more practical in evaluating man-caused effects on inland saline ecosystems, even though the effects of stresses on individual populations can be physiologically quantifiable. (See W70-04761). (D'Arezzo-Texas)
W70-04766

ECOLOGICAL ASPECTS OF STREAM POLLUTION,
Texas Univ., Austin.
Neal E. Armstrong, and Earnest F. Gloyna.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F. and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968, p 83-95, 7 fig, 25 ref.

Descriptors: *Ecology, *Respiration, *Oxygen demand, *Ecosystems, *Model studies, *Stability, Plant growth, Energy, Design, Classification.
Identifiers: *Species-diversity index, *Diurnal curve, *Stream pollution, *Energy exchanges, *Gas exchanges, *Nutrient flows, *Energy-P/R relationship, Trophic levels, Organic transfer, Univ of Texas, Reaeration coefficient.

Two methods of evaluating the effects of pollution on the ecological system are presented, which furnish valuable information to the engineer regarding the condition and stability of ecological systems in receiving waters, and may ultimately become design criteria. Gases, nutrients and energy interchanges take place between components of the ecosystem. Gas exchange is related to plant and animal activities in photosynthesis and respiration; nutrient flows relate to the recycling processes and, energy integrates the ecosystem and can be described in thermodynamic terms. The species-diversity index method-the relation of individuals to species--has been used in comparing types of waters. The diurnal curve method has been used to find the total oxygen production and respiration in natural waters. Ecosystems may be classified according to oxygen production (P) and respiration (R) values and also their P/R ratios. Correlational analyses between energy stabilization and the P/R ratios afford significant insights into specific pollutional effects on ecosystem stability. Model studies at Univ of Texas are attempting to develop predictive curves for (P) and (R) against various waste parameters. (See W70-04761). (D'Arezzo-Texas)
W70-04767

ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
Manhattan Coll., Bronx, N.Y.
Donald J. O'Connor, and Dominic M. Di Toro.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 96-102, 4 fig, 5 ref.

Descriptors: *Dissolved oxygen, *Continuity equation, *Reaeration, *Photosynthetic oxygen, *Natural streams, Variability, Aeration, Differential thermal analysis, Carbonates, Nitrogen compounds.
Identifiers: *Dissolved oxygen concentration, *Sources and sinks of oxygen, *Mass balance equation, *Natural aeration, *Artificial aeration, *Dissolved oxygen deficits, Fourier series expansion, Grand River, Lansing (Mich).

An analytical, mathematical example is presented which gives some insight into the complex relationships governing the oxygen balance in streams. The distribution of dissolved oxygen in a natural stream is definable by the continuity or mass balance equation in mathematical differential equation form. The equation describes temporal dissolved oxygen variation according to a spatial distribution along the axis of stream flow, and assumes a uniform concentration over the stream cross-section area. Both flow and cross-section area can be functions of space and time. The oxygen sources and sinks can be space, time and concentration functions. The concentration of dissolved oxygen is selected for this analysis. (However equation is applicable to any substance.) The sources of oxygen are the tributary inflows and brought about by natural or artificial aeration and by photosynthetic activity of green plants. The sinks of dissolved oxygen include biochemical oxidation of organic matter, use by benthal deposits and by aquatic plant respiration. Each of the above cited parameters are formulated into mathematical components of the continuity or mass balance equation. An illustrative analysis is made of the oxygen distribution in the Grand River near Lansing, Michigan. (See W70-04761). (D-'Arezzo-Texas)
W70-04768

RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
Texas Univ., Austin; and Louisiana Polytechnic Inst., Ruston.
Frank D. Masch, and Joe R. Wilson.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 103-110, 17 ref.

Descriptors: *Natural streams, *Diffusion, *Dispersion, *Turbulent flow, *Mathematical studies, *Eddies, *Pollution abatement, *Theoretical analysis, Flow characteristics, Estuaries, Reynolds Number.
Identifiers: *Fick's Laws of Diffusion, *Coefficient of diffusion, *Physical exchange, Assimilative capacity, Brownian motion, Molecular diffusion, Non-isotropic diffusivity, One-dimensional diffusion, Three-dimensional diffusion, Differential continuity equation, Prandtl's mixing length.

The efficient us of assimilative capacities of natural streams requires knowledge of the vital mixing, dispersion, diffusion and physical exchange processes. The term 'coefficient of dispersion' is normally used to describe the apparent diffusivity resulting from all mixing and exchange processes. A thorough theoretical analysis traces the mathematical expression of the process of diffusion from Fick's Laws of Diffusion through the analytical postulations of Prandtl based on the kinetic theory of gases, on to various empirical simplifications regarding shear flow mixing by subsequent investigators. Theoretical methods cannot always be based on a time-independent coefficient of dispersion. Before any analytical solutions of the diffusion equation can be obtained, the dispersion coefficient must be known, assumed, or measured; and generalizations must be made for variations in stream and estuary velocity, cross-sectional areas, and the dimensionality of flow. In any event, these assumptions are complicated by the intrusion of numerous variables and the usual prevalence of non-uniform, unsteady turbulent flows. Nevertheless the joint use of mathematical analytical methods and sampling programs may serve useful planning purposes. (See W70-04761) (D'Arezzo-Texas)
W70-04769

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
Boeing Co., Huntsville, Ala.; and Vanderbilt Univ., Nashville, Tenn.
James R. Hays, and Peter A. Krenkel.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 111-123, 7 fig, 2 tab, 16 ref.

Descriptors: *Mathematical models, *Mixing, *Rivers, *Continuity equations, *Tracers, *Flow characteristics, *Laboratory tests, *Flumes, *Forecasting, *Mass trasfer, *Stagnant water, Flow rates.
Identifiers: *Turbulent flow, *Dead zone model, *Longitudinal mixing coefficients, Differential equations, Kalmogoroff's similarity principle, Concentration-time curves, Dispersed flow, Tennessee Valley Authority, Prediction.

Natural processes of waste dilution and purification in rivers, streams, lakes, and reservoirs are enhanced by natural mixing and dispersion. These phenomena require ample time and distance. Effective means of predicting the natural mixing and dispersion capabilities of receiving waters would enable better pollution control. Available field data usually indicates higher values when compared to mathematical models successfully tested in laboratory flumes. To ascertain the causes of this discrepancy, an analysis is made of the relevant mixing theories and empirical, numerical expressions including the continuity equations for turbulent flow and pipe flow methods for computing the longitudinal mixing coefficient using experimental data, hydraulic parameters, and Kolmogoroff's similarity principle. A so-called 'dead zone' model is proposed which takes into account stagnant areas, usually existing in receiving waters and the inadequacies of the one-dimensional representation of the mixing phenonemon are discussed. This model assumes that part of the tracer material injected in a river enters stagnant zones from which it emerges slowly. Model was tested in a laboratory flume and in several TVA rivers. Observed and predicted time-tracer concentration curves compared favorably. (See W70-04761). (D'Arezzo-Texas)
W70-04770

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
Resources for the Future, Inc., Washington, D.C.; and California Univ., Berkeley.
Richard J. Frankel, and William W. Hansen.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F. and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 126-140, 4 fig, 1 tab, 17 ref.

Descriptors: *Dissolved oxygen, *Model studies, Waste assimilative capacity, *Photosynthesis, *Respiration, *Oxygen demand, *Mathematical models, *Computer models, Mixing, Waste disposal, Oxygen sag, Sediments, Digital computers.

Identifiers: *Oxygen profile equations, Streeter-Phelps equation, *Stream quality, *Water quality, Case studyoFlint River-Lansing, (Mich), Management, Model applicability, Model sensitivity.

An expression has been developed to predict the spatial and temporal variations in dissolved oxygen concentrations in receiving natural waters. A case study, using digital computer methods, shows the validity of oxygen profile equations, provided proper inputs are used. Input data needed for complete use of the mathematical model showed that present stream survey practices do not afford enough data to describe the biological and physical responses in a stream. Data collection should be governed by sensitivity analysis namely, extent and oxygen demand of the sediments, biological extraction rate of attached organisms, and maximum rate of oxygen production (consumption) by photosynthesis (respiration). Diurnal fluctuations in waste loads, variations in reaction rates, and photosynthetic action in the stream have stronger effects on resulting conditions than generally believed. There is need for improving present predictive techniques used in evaluating pollution effects. (See W70-04761). (D'Arezzo-Texas)
W70-04771

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
Karl Wuhrmann.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 143-170, 5 fig, 15 tab, 21 ref.

Descriptors: *Activated sludge, *Research and development, *Oxygen, *Growth rates, Bacteria, Photosynthetic bacteria, Photosynthesis, Respiration, Nitrification, Ammonia, Treatment facilities, Trickling filters, Fermentation, Assay.
Identifiers: *Excess sludge production, *Removal efficiencies, *Organic carbon, *Organic nitrogen, *Sludge-loss factor, Plant operation, Oxygen consumption, Sludge plants, Concept of continuous operation, Sludge loads.

The influence of hydraulic load, solids and oxygen concentration, and the temperature of the mixed liquor on the performance of the activated sludge process was investigated. A complete block factorial design experiment was conducted where the independent variables were tested at 3 levels temperature at 2 levels. A set of assays was evaluated on the basis of the theory of continuous fermentation in a completely mixed reactor. Studies were made of main actions and interactions of the independent variables on removal of organic carbon, organic nitrogen, BOD, and on production of excess sludge. Estimates are given of the gross yield factor in terms of organic carbon for calculation of excess sludge quantities. Growth rate of the bulk of sludge organisms is discussed. A causal formula is developed for finding the oxygen consumption in an aerator. Numerical values for endogenous and substrate respiration as function of plant operation parameters are presented based on experimental operations. There is a need for more reliable data on growth rates of sludge organisms and a better knowledge of the magnitude of the sludge loss factor under various conditions. (See W70-04761). (D'Arezzo-Texas)
W70-04772

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
Rice Univ., Houston, Tex.
A. W. Busch.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 171-175, 5 ref.

Descriptors: *Systems analysis, *Mathematical models, *Biological treatment, *Activated sludge, *Trickling filters, Nitrates, Nitrogen, Oxygen.
Identifiers: *Fluidized culture systems, *Biological oxidation, *Anaerobic systems, *Film-flow biological reactor, Warburg apparatus, Curve-fitting, Methane forming organisms.

Water technology is being pressed between concepts based on conventional, stereo-typed system design and new scientific knowledge. Two concepts derived from interdisciplinary activities are systems theory and mathematical models. As a result many misconceptions have arisen. Using examples in various facets of biological oxidation processes and concepts it is demonstrable that, generally, systems knowledge is more powerful than systems theory. Also, the equations of mathematical models and thermodynamic analysis must be descriptive before they can be used predictively. The following specific oxidational processes and concepts were analysed: (1) fluidized culture systems, (2) the use of nitrates as a source of 'chemical oxygen' in biological oxidation, (3) anaerobic systems which have assumed traditionally a two-stage sequence of biological reactions which exclude exogeneous hydrogen acceptors and depends on methane-forming organisms, and (4) the film-flow biological reactor. With respect to mathematical modeling the point is made that the model should serve as a description to work from rather than toward. And, in general, systems theory places serious overall limitations on processes; this is illustrated in specific cases regarding fluidized culture process. (See W70-04761). (D'Arezzo-Texas)
W70-04773

REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
Minnesota Univ., Minneapolis.
Walter K. Johnson.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, univ of Texas Press, 1968. p 178-189, 4 fig, 2 tab, 38 ref.

Descriptors: *Biological treatment, *Nutrients, *Nitrification, *Denitrification, *Flow control, Nitrogen, Phosphorus, Wastewater treatment, Ecology, Eutrophication, Activated sludge, Trickling filters, Dissolved oxygen, Aeration, Control, Disposal, Incineration, Digestion.
Identifiers: *Nitrogen removal, *Wastewater effluent, Bioprecipitation processes, Stabilization ponds, Semiaerobic activated sludge process.

From data now known, it appears that reduction of nitrogen and phosphorus in wastewater plant effluents is vital in controlling eutrophication. However, other ecological factors may determine whether nitrogen or phosphorus, alone, limit algal growth in any given situation. Thus, the removal of solids and elements other than nutrient elements should not be neglected. Total solids removals may be necessary. Until higher degrees of removal are deemed necessary and economically feasible much can be done to increase the efficiency of nitrogen and phosphorus removal capabilities in plants and processes. Specific analyses and improvement suggestions are presented regarding: (1) the physical methods of removal, (2) bioprecipitation processes, (3) stabilization ponds, (4) nitrification and denitrification processes, and (5) nitrogen disposal. (See W70-04761). (D'Arezzo-Texas)
W70-04774

FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
Water Pollution Research Lab., Stevenage (England).
A. L. Downing.
Advances in Water Quality Improvements, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, University of Texas Press, 1968. p 190-202, 8 fig, 14 ref.

Descriptors: *Design, *Activated sludge, *Aeration, *Oxidation, *Nitrification, Retention, Sewage, Ammonia, Temperature, Effluents.
Identifiers: *Longitudinal mixing, *Biological oxidation, *Loading, *Sludge settleability, *Sludge dewaterability, *Sludge production, Nitrified effluents, Carbonaceous matter, Biological oxygen demand, Retention period, Sewage retention, Carbonaceous oxidation.

To approach closer to optimization in the design of an activated sludge plant of required capacities more data is needed pertaining to the inter-relationships between operating variables and performance. Laboratory studies have revealed some ways of improving plant performance through design and operational changes. The effects of retention period and loading are examined in the specific areas of nitrified effluent production, carbonaceous matter removal, sludge production and sludge settleability and dewaterability. The degree of longitudinal mixing in aeration units with important effects heretofore seemingly neglected, are also examined. The status of knowledge on effects of mixing on biological oxidation, and the effects of mixing and concentration on the influence of inhibitory substances are analyzed. An assessment is made of the patterns, capacities, rates and efficiencies of aeration processes and methods. (See W70-04761). (D'Arezzo-Texas)
W70-04775

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
Cornell Univ., Ithaca, N.Y.
Vaughn C. Behn, and Parviz Monadjemi.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univerisity of Texas Press, 1968. p 204-214, 3 fig, 18 ref.

Descriptors: *Biological treatment, *Filtration, *Mathematical studies, *Trickling filters, *Mathematical models, Biochemical oxygen demand, Filters, Waste treatment, Flow characteristics, Design.
Identifiers: *Biological filtration, *Empirical models, *Recirculation filters, *Reaction kinetics, *Flow patterns, *High-rate trickling filters, Mass transfer coefficients, System design, Plug-flow, Mixed-flow.

A review is made of the major empirical and mathematical formulations for single-stage filters and recirculating filters and to define the process action of trickling filtration. Recirculation is an established fact with the operation of high rate trickling filters, affording uniformity and equalization of loadings, flexibility of plant operation and, beneficial seeding effects on plant influent. Some new concepts are presented concerning certain major factors which affect the performance of a biological treatment system. A continuous flow system includes some reactor (i.e., an activated sludge, a trickling filter or a sedimentation basin process) which has the function of reducing some undesirable property associated with the flow. The efficiency of such a system depends mainly on: (1) the type flow pattern of material passing through the system and, (2) the kinetics of the reaction itself. The effects of plug flow and completely mixed flow patterns on the efficiency of a system undergoing a first-order treatment reaction are described. The importance of bacterial concentration in most biological treatment systems regardless of the type of flow pattern is emphasized. Practical observations are made on the relationships of flow to bacterial concentration in determining the efficiency of trickling filter systems. (See W70-04761). (D-'Arezzo-Texas)
W70-04776

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
Texas Univ., Austin.
W. Wesley Eckenfelder, and Davis L. Ford.

Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, University of Texas Press, 1968. p 215-236, 14 fig, 3 tab, 27 ref.

Descriptors: *Aeration, *Oxygen, *Transfer, *Diffusion, *Mixing, *Surfactants, *Temperature, *Equations, *Design data, Mass transfer, Activated sludge, Equipment (Aeration), Bubbles (Aeration), Turbulence.
Identifiers: *Overall transfer coefficient, *Liquid film coefficient, *Mass transfer coefficients, *Oxygen transfer efficiency, Deoxygenated water, Steady-state aeration, Nonsteady state aeration, Mixing intensity, Surface active agents, Diffused aeration, Turbine aeration.

A general review is made of recent concepts in oxygen transfer and the practical data for design of aeration equipment is summarized. The theory and general development of the mechanism of oxygen transfer under quiescent and turbulent conditions are discussed. The most significant factors influencing the important overall transfer coefficient and the liquid film coefficient are temperature surface active agents in the liquid, and mixing intensity. Empirical mathematical expressions are presented for the temperature effect and for the film of excess surface concentration of surfactant molecules which serves as a barrier to diffusion. The effects of various mixing intensity ratios on oxygen transfer rates, under various aeration systems and flow regimes are shown graphically. The most commonly-accepted techniques used to determine aeration equipment performance efficiency and capabilities are: (1) nonsteady state aeration of deoxygenated water, (2) steady-state and nonsteady-state aeration of activated sludge, and (3) steady-state aeration of tap water. Aeration equipment used for sewage and industrial waste treatment consists of air diffusion units, turbine aeration systems in which air is released below the rotating blades of an impeller, and surface aeration units in which oxygen transfer occurs by virtue of high surface turbulence and liquid sprays. (See W70-04761). (D'Arezzo-Texas)
W70-04777

AERATION DEVELOPMENTS IN EUROPE,
Technische Hochschule, Vienna (Austria).
Wilhelm Von der Emde.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univerisity of Texas Press, 1968. p 237-261, 23 fig, 1 plate.

Descriptors: *Aeration, *Diffusion, *Oxygenation, *Absorption, *Efficiencies, *Energy, *Sewage treatment, Bubbles, Design. Detergents, Baffles, Circulation, Design data.
Identifiers: *Danjes system, *Cone aeration, *Saran-tube aerator, *Brandol-tube aerator, *Plastic-box aerator, *Germany, Simplex cone, Oxygen absorption, Europe, Munich, Essen, Hamburg, Simcar cone, Vortair cone, BSK turbine, Mammut-Rotor.

Before the construction of large sewage treatment plants in Austria, investigations were made of major treatment facilities involving large scale aeration processes in Essen, Hamburg and Munich, Germany. The performance and economics of major aeration systems are discussed. The Essen plant tested the oxygenation efficiencies of Saran-tube, plastic box and Brandol-tube aerators under various arrangements as to location and bubble size. Results of the Danjes fine bubble aeration system at Munich are furnished. Results of widespread use of Simplex cone aeration throughout Europe are summarized. Major differences between the Simcar cone aeration system and the Vortair cone system are noted. Special operational and power requirements of the BSK Turbine aeration system is noted. Modifications to aerators and rotors leading to the development of the Mammut-Rotor are explained showing effects of immersion depth on absorbed energy aeration efficiency, and oxygen capacity. Comparisons are made with the Haworth paddle aeration system and the Kessener brush aeration system. (See W70-04761). (D'Arezzo-Texas)
W70-04778

MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
Michigan Univ., Ann Arbor; and Clemson Univ., S.C.
K. H. Mancy, and W. E. Barlage, Jr.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press 1968. p 262-286, 18 fig, 22 ref, 2 plates.

Descriptors: *Aeration, *Interfaces, *Surfactants, *Physicochemical properties, *Films, *Testing, Gases, Adsorption, Hydrodynamics, Mass transfer, Aerosols, Reynolds number, Mixing.
Identifiers: *Bubble aeration, *Stream aeration, *Surface aeration, *Liquid laminar jet system, *Gas transfer, *Surface active agents, Interfacial resistance, Dynamic surface tension, Dynamic surface concentration, Oxygen transfer coefficient.

Continued attention has been given to the effects of water soluble surface active agents, (SAA) on aeration processes. All experiments to date have encountered certain conflicting results which indicate that the presence of SAA in aeration systems may affect greatly the hydrodynamics of the air-water interface and, therefore, the rate of gas transfer. The physicochemical characteristics of the air-water interface have been examined closely in various systems including bubble aeration, stream aeration, surface aeration in stirred vessels, and liquid laminar jet systems. In comparing the results from these three different aeration systems, better understanding has been gained of the mechanism of interference of SAA on gas transfer. The degree of reduction of gas transfer rates caused by SAA in aeration systems depends on the hydrodynamics of the contactor and the chemical properties of the given SAA. There are two types of SAA interference with gas transfer, (depending on the structure and physicochemical properties of the SAA): (1) The SAA adsorbed film covers partially or totally the water surface, blocks dissolution sites at the interface, or distorts intermolecular forces between the gas molecule and the water surface necessary in the dissolution process. (2) The SAA increases the water surface viscosity, suppresses the interface hydrodynamic activity and, forms a viscous subsurface hydration layer. (See W70-04761). (D'Arezzo-Texas)
W70-04779

FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
Wisconsin Univ., Madison.
W. C. Boyle, K. Crabtree, E. P. Jaccarino, E. N. Lightfoot, and G. A. Rochlich.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press 1968. p 287-312, 2 fig, 4 tab, 60 ref, 4 plates.

Descriptors: *Flocculation, *Coagulation, *Activated sludge, *Bacteria, *Colloids, *Aggregates, Aeration, Hydrodynamics, Protozoa.
Identifiers: *Biological flocculation, *Rate of collision, *Collision frequency, *Biological systems, *Adhesive forces, *Disruptive forces, *Zoolgoea ramigera, *Bacterial flocculation, Polymerization, Agglomerations (Capsular, gelatinous matrix, protozoan).

There is a need for better understanding of the quantitative aspects of the biological flocculation process such as flocculation rates, size distributions, and effects of aggregates. Determination of these quantitative data requires actions to estimate floc collision rates, to evaluate the effectiveness of collisions and, to measure the relative adhesive and disruptive forces. The literature on colloid coagulation is reviewed to ascertain its usefulness and limitations. Current qualitative theories regarding cohesive forces are reviewed. The qualitative theory of floc formation for pure cultures of Zoogloea ramigera is discussed. Review of factors affecting the rate and size distribution of colloid aggregation is divided into three areas: (1) Population balances, (2) Prediction of collision frequency, which depends mainly on classical kinetic theory and hydrodynamics, (3) Description of disruptive forces, which are mainly hydrodynamic for bacterial flocs, and which tend to provide an upper limit for the size of primary aggregates. The categories of microbial aggregation concepts discussed are: (1) Capsular or gelatinous matrix agglomeration, (2) Colloidal hypotheses, (3) Protozoan agglomeration, (4) Inert matrix and salt-bridging hypotheses, (5) Low-energy concepts, and (6) Polymerization. (See W70-04761). (D'Arezzo-Texas)
W70-04780

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
Hydroscience, Inc., Leonia, N.J.
John L. Mancini, and Edwin L. Barnhart.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 313-324, 7 fig.

Descriptors: *Industrial wastes, *Waste treatment, *Aeration, *Activated sludge, *Data collections, *Laboratory tests, *Design, Activated sludge, Aerobic treatment, Digestion, Pilot plants, Temperature, Biochemical oxygen demand, Chemical oxygen demand, Suspended load, Economic impact.
Identifiers: *Aerated lagoons, *Low-solids production, *Suspended solids, *Aeration time, *Response function, *System constants and coefficients, *Laboratory data extrapolations, System response, BOD removal, Oxygen requirements, Numerical examples, Operating problems.

Data collection technique can be designed to establish a response function affording economic evaluation and alternative treatment options. A laboratory method is demonstrated which can be used to evaluate, compare, and design activated sludge, low solids production and aerated lagoon treatment systems from a single set of experimental data. The technique of handling activated sludge and aerated lagoon data in a continuous manner has proved effective in evaluating biological treatment systems. Performance predictions can be extrapolated from laboratory data for different waste strengths and aeration detention times. Technique permits determination of equilibrium solids in aerated lagoon systems and solids requiring handling and disposal in activated sludge systems. Methods of predicting aerated lagoon temperatures and performance have been illustrated. Pilot plant data can be studied to find or analyze: response functions for waste under question, ranges for coefficients and system constants, toxicity effects, sludge settling and separation, temperature effects and foaming problems. (See W70-04761). (D-'Arezzo-Texas)
W70-04781

NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
Metcalf and Eddy, Boston, Mass.
Clair N. Sawyer.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 325-335, 7 fig, 7 ref.

Descriptors: *Aeration, *Design criteria, *Wastewater treatment, Aerbobic conditions, Anaerobic conditions, Equipment (Aeration), Industrial wastes, Land, Activated sludge, Temperature, Biochemical oxygen demand (BOD), Treatment facilities.
Identifiers: *Aerated lagoons, *Mixed aerobic-anaerobic systems, *Aerobic systems, *Aerated

lagoon design, *Multiple aeration units, Heat loss, Temperature loss compensation, Detention time, Trickling filters, Activated sludge, Oxidation ponds, Stabilization ponds.

The aerated lagoon method of wastewater treatment provides economical high-degree treatment, with land requirements ranging from 1 to 10% of those needed for oxidation or stabilization ponds, and not larger than requirements for high-rate rock-type trickling filters. The further potentials and capabilities of the aerated lagoon method are examined in the light of currently improved knowledge of biological phenomena and other environmental factors. An analytic comparison is made of the mixed aerobic-anaerobic lagoon system versus the aerobic system; the choice in any given project requires careful engineering evaluation. Temperature considerations enter prominently in aerated lagoon system design in view of the excellent heat--dissipating properties afforded and the close relationship between BOD removal and temperature. The major advantage of the aerated lagoon over other methods of biological treatment is its great diluting capacity and ability to handle highly varied types of wastewaters. One of the major problems of design is the selection of aeration equipment. Generally, in large installations, mechanical-type aerators are favored over diffused air because of greater mixing potential and economy of installing electric lines versus air lines over large distances. The type of equipment to be selected depends heavily on whether the system being designed is based on the aerobic or aerobic-anerobic concept. (See W70-04761). (D-'Arezzo-Texas)
W70-04782

ANAEROBIC TREATMENT OF SOLUBLE WASTES,
Stanford Univ., Calif.
Perry L. McCarty.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 336-352, 6 fig, 3 tab, 35 ref.

Descriptors: *Waste treatment, *Anaerobic conditions, *Design criteria, *Fermentation, *Methane bacteria, *Kinetics (Waste treatment), Bacteria, Biological treatment, Biological communities.
Identifiers: *Anaerobic waste treatment, *Soluble wastes, *Solid retention time (SRT), *Anaerobic process designs, *Anaerobic filter process, Microbiology, Biochemistry, Anaerobic activated sludge process, Anaerobic contact processes.

Anaerobic treatment of soluble wastes has the following advantages over aerobic treatment: (1) high loading rates with little production of biological solids for disposal, (2) lower power requirements, (3) useful production of methane as an end-product. Anaerobic contact processes have been developed, producing more rapid and efficient treatment, and enabling more economical treatment of relatively dilute wastes at ambient temperatures. Efficient anaerobic treatment of soluble wastes with BOD as low as 500 mg/l is now feasible. The best process for diluted waste treatment may be a two-stage operation: (1) anaerobic treatment for waste stabilization, (2) aerobic treatment for effluent polishing. The biological solids rentention time (SRT) is deemed the best parameter of anaerobic treatment control. A minimum SRT exists,-'a breaking point'-below which the critical methane-producing bacteria are removed faster than they can reproduce themselves. With very high SRT values, highly efficient treatment at lower temperatures can be obtained. The 'aerobic filter' appears one of the most promising contact processes for soluble waste treatment, permitting very high SRT's up to 100 days, and affords virtually all major benefits of anaerobic waste treatment process. (See W70-04761). (D'Arezzo-Texas)
W70-04783

NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
Texas Univ., Austin.
Joseph F. Malina, Jr., and Earnest M. Miholits.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 355-379, 10 fig, 5 tab, 38 ref, 3 plates.

Descriptors: *Anaerobic conditions, *Digestion, *Sludge treatment, *Sludge disposal, *Sludges, *Chemical properties, *Solids contact processes, Chemical degradation, Organic compounds, Temperature, Mixing, Digestion tanks, Design criteria, Alkalinity.
Identifiers: *Biochemical reactions, *Anaerobic sludge digestion, *High-rate digestion, *Carter-Pearth gas recirculation systems, 'Shearfusers', Gaslifter digestion system, 'Bubble guns', 'Dynomix' system, 'Densludge' system, 'Aero-Hydraulic' system.

Primary and biological sludge treatment and disposal generated from wastewater treatment present more difficult problems than liquid waste treatment alone. The complexity of biochemical reactions involved in the liquefaction and gasification of wastewater sludges indicates vital need for external and internal control of the reaction variables. Optimum digestion requires solids mixing in a digestion tank by mechanical or gas recirculation methods, within the temperature range of 30 deg-35 deg C. The recommended volatile solids loading is 200 lb/1,000 cu.ft/day, with a detention time of from 10 to 15 days. Digester performance will be improved by maintaining the solids loading and hydraulic displacement as uniform as possible. The various chemical parameters characterizing the digester environment are sensitively interrelated. Therefore, for efficient digestion operations it is essential to determine and evaluate carefully the daily laboratory analyses of volatile acids, the alkalinity, the digestion sludge gases, pH, carbon dioxide production and other critical parameters of the particular wastes being treated. (See W70-04761). (D'Arezzo-Texas)
W70-04784

KINETICS OF BIOLOGICAL TREATMENT,
California Univ., Berkeley.
Erman A. Pearson.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 381-393, 3 fig, 2 tab, 7 ref.

Descriptors: *Aeration, *Biological treatment, *Biological properties, Kinetics, Equations (Kinetics), Mathematical models, Oxygen demand, Effluents, Growth rates, Growth stages, Nutrients.
Identifiers: *Extended aeration, *Biological processes, *Michaelis-Menten growth model, *System kinetics, *Kinetic models, Organic substrate removal, Biological process constants, Nutrient removal.

A consistent and rational basis for a kinetic description of both aerobic and anaerobic waste treatment systems is presented. The kinetic model for growth and enzyme substrate removal is based upon that of Michaelis-Menten, and substrate and cell material balance equations including a decay term constitute the basic kinetic descriptions of the process. The need for further laboratory and field determinations of applicable kinetic constants is emphasized. A summary of currently known data on aerobic and anaerobic constants is furnished. The use of kinetic modeling in interpreting biological processes, such as extended aeration is demonstrated. An extended aeration plant is one where the net growth rate is made to approach zero; that is, growth is about equal to decay. An analytical approach to maximum growth processes for application in nutrient removal operations is presented. If aerobic and anaerobic treatment processes are to be evaluated for a specific waste treatment problem on a rational economic feasibility basis, the development of accurate kinetic constants for both processes is vital. (See W70-04761). (D-'Arezzo-Texas)
W70-04785

BASIS FOR WASTE STABILIZATION POND DESIGNS,
Texas Univ., Austin.
Earnest F. Gloyna.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 397-408, 1 fig, 1 tab, 19 ref.

Descriptors: *Waste treatment, *Stabilization, *Ponds, *Design criteria, Facilities, Equations, Aerobic conditions, Anaerobic conditions, Algae, Algal control, Ecological distribution, Activated sludge, Maintenance costs, Construction costs.
Identifiers: *Waste stabilization ponds, *Algal physiology, *Design theory and calculations, Photosynthesis, Illumination, Temperature, Nutrients, Facultative pond designs, BOD, Sludge.

Many problems arising from use of waste stabilization ponds are traceable to inadequate engineering, poor maintenance and lack of operational supervision. However, there is a more fundamental need: Design and engineering for systems using stabilization ponds must be based on an understanding of the principles of algal physiology. Generally, algae growing in a stream or a waste stabilization pond are in a highly competitive environment. One or more of the factors necessary for photosynthesis are interrelated, and unicellular algae, in particular will react rapidly to environmental changes. Illumination, temperature, and nutrients--the factors which affect growth rate are examined critically. The phenomena of algal physiology, together with actual treatment objectives are synthesized in good design. In the final analysis, the specific design of a waste stabilization pond depends heavily upon the specifically-imposed treatment objectives and requirements. A pond system may be designed to receive untreated sewage or industrial wastes, primary or secondary treatment effluents or excess activated sludges and settleable solids. Certain critical factors in design development are discussed, based on operational experiences and research which provide vital insights into environmental factors governing waste stabilization processes. (See W70-04761) (D'Arezzo-Texas)
W70-04786

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
California Univ., Berkeley.
W. J. Oswald.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 409-426, 6 fig, 2 tab, 11 ref.

Descriptors: *Waste treatment, *Stabilization, *Ponds, *Environmental effects, *Biological treatment, *Design criteria, Dissolved oxygen, Temperature, Biochemical Oxygen Demand (BOD), Evaporation, Fermentation, Methane, Algal control, Bacteria, Coliforms.
Identifiers: *Anaerobic waste ponds, *Depth effects, *Hydraulic load effects, *Organic load effects, *Detention time effects, *Faculative ponds, *Aerobic ponds, *Anaerobic ponds, Design for environmental control, Recirculation, BOD removal, Gas production.

The biological actions and interactions in waste stabilization ponds have been complex enough to deter scientific investigation and thus to foster the widespread use of empirical design formulations which are based on limited data. Recognition of the fact that sedimentation and four basic biological reactions interact in ponds, makes possible a rational design of ponds. Precise formulas have not yet been developed governing all variables. However, the relationships between temperature and methane fermentation, depth and temperature, and between depth and oxygenation are well-

established. Methane fermentation is the sine qua non for aerobic and facultative ponds; therefore, designs maximizing temperature uniformity and minimizing oxygen intrusion are most successful. In series ponds, which recycle oxygenated water, the prevention of odor in the initial anaerobic pond is done easily by overlaying the primary anaerobic pond with oxygenated water. For destruction of coliform bacteria, both time and temperature are vital factors. At normal pond temperatures, obtaining time increments by depth increases is easier than getting temperature increments by depth decreases. Wastes having high carbon/nitrogen ratios must be oxidized and aerated before fermentation. (See W70-04761). (D'Arezzo-Texas)
W70-04787

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
Federal Water Pollution Control Administration, Dallas, Tex.
Jerome H. Svore.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 427-434, 2 fig, 2 tab, 8 ref, 1 plate.

Descriptors: *Stabilization, *Ponds, *Design, *Efficiencies, *Chlorination, *Odor, *Waste treatment, Algae, Disinfection, Biochemical Oxygen Demand (BOD), Aeration, Coliforms, Algal control, Dissolved oxygen.
Identifiers: *Aerated lagoons, *Midwest (US), *Southwest (US), *Design criteria, Pond effluent, Colorado, West (US), Stabilization pond loadings, Odor persistence.

The design, operations, and gradual acceptance of waste stabilization ponds in the Southwest during the past 25 years is traced. Recent surveys in Colorado have substantiated general experience in the Midwest, classifying the predominant defects in design, construction, and operation into three classes: (a) liquid depth not maintained, (b) water surface inadequate, and (c) primary solids not evenly distributed. A comparison is made of current methods used throughout the southern half of the United States regarding the excessive algae problem. The determination of lagoon treatment efficiency must be made from the viewpoint of regional water priorities and objectives. The reduction in required chlorine disinfection usage resulting from efficient pond operation is discussed. Some reasons for the trend toward greater use of aerated lagoons are presented. While there are still isolated areas where opinion exists that waste stabilization ponds are dangerous, undesirable and, a health hazard, the major trend is toward recognition that if ponds are designed and operated properly (in series), they will provide more treatment per unit cost than any other single process. (See W70-04761). (D'Arezzo-Texas)
W70-04788

WASTE STABILIZATION POND PRACTICES IN CANADA,
Waterloo Univ. (Ontario).
Charles P. Fisher, W. R. Drynan, and G. L. Van Fleet.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 435-449, 2 fig, 1 tab, 21 ref.

Descriptors: *Stabilization, *Ponds, *Sewage treatment, *Design criteria, *Climatic zones, *Efficiencies, *Odors, Wastewater treatment, Coliforms, Operations.
Identifiers: *Canada, *Prairie provinces, *Northwest territories, *Climatic conditions, Multiple pond requirements, Loading rates.

The waste stabilization pond form of wastewater treatment is gaining acceptance in Canada. The trend is to use this treatment for domestic wastes from large cities. Generally, the efficiency is affected significantly by climatic conditions. Summertime BOD5 removal efficiencies vary between 65% and 90%; winter efficiencies vary between 0% and 55%. Coliform reduction exceeding 99% has been achieved within some ponds. Waste stabilization ponds in the Prairie provinces and in the Northwest Territories, where there are severe winters, are designed for complete winter storage. Elsewhere in Canada ponds are generally continually discharging. Waste stabilization pond treatment systems, consisting of short detention (anaerobic) ponds in series with long detention (facultative) ponds, are also gaining acceptance in the Prairie provinces. Pond organic loading rates vary generally between 10 and 45 lbs. BOD5/acre/day. Odors are commonly associated with the break-up of ice during the springtime on ponds in the Prairie provinces. (See W70-04761). (D'Arezzo-Texas)
W70-04789

EXTRA-DEEP PONDS,
Technion - Israel Inst. of Tech., Haifa; and Water Planning for Israel Ltd., Tel Aviv.
Alberto M. Wachs, and Andre Berend.
Advances in Water Quality Improvement, (Editors Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 450-456, 5 fig, 1 tab, 9 ref.

Descriptors: *Ponds, *Stabilization, *Thermal stratification, *Seasonal, *Sulfides, Temperature, Climatic data, Stratification, Dissolved oxygen, Algae, Biochemical Oxygen Demand (BOD), Mixing, Winds.
Identifiers: *Thermal gradient, *BOD removal, *Israel, *Algal concentration, 'Extra-deep ponds', Ashkelon (Israel), Temperature profiles, Volatile suspended solids, Multi-cell serial system, pH, Facultative pond, Anaerobic pond.

An experimental unit was built by Tahal, Ltd, near the wastewater treatment facility, Ashkelon, Israel, to obtain pilot plant performance data on 'extra-deep' waste stabilization ponds, (i.e., depth greater than 8 feet). The experience gained shows that when loadings acceptable to the Israel climate were used during the warm season, a pronounced thermal gradient caused the upper part of the pond to behave as a 'separate' facultative pond 'floating' on an underlying anaerobic pond. This stratification was enhanced by the fact that both inlet and outlet were located at the surface. Effluent was rich in algae. During the warm season, algal concentrations were much lower at or below depths of 1 meter; therefore, placing of outlet at that depth would draw off better effluent insofar as algal density was concerned, but it was deficient in dissolved oxygen at times. The thermal gradient disappeared during the cold season. Mixing was due mainly to wind action and influenced by pond geometry. Dissolved oxygen was not always present in the upper pond layers but it did contain considerable algae. During fall, a pond turnover occurred resulting in mixing of lower and upper layers. This caused a surface increase of sulfides concentration, a drop in pH, but no odors. During both cold and warm seasons, BOD removal was about 80%. (See W70-04761). (D'Arezzo-Texas)
W70-04790

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
California Univ., Davis; and Kansas State Univ., Manhattan.
Samuel A. Hart, and Marvin E. Turnet.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 457-463, 2 tab, 6 ref.

Descriptors: *Waste treatment, *Stabilization, *Ponds, *Design criteria, *Anaerobic digestion, Sludge, Disposal, Odors, Mosquitoes, Insect control, Subsurface waters, Infiltration, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD).
Identifiers: *Agricultural wastes, *Manure stabilization pond, *Livestock manure characteristics, *Pond loading rates, *Pond appearance and location, Sludge digestion, Sludge disposal.

In contrast to sewage and other wastewater stabilization ponds, manure disposal ponds are expected to accept very large amounts of organic solid matter, often with scarcely enough water to get the wastes into the pond. The objective is stabilization and disposal of organic matter rather than water purification; effluent is lacking; make-up water is often needed. Biochemical oxygen demand (BOD) loading ranges up to 1200 lbs/acre/day; anaerobic conditions predominate; and are functionally comparable to open unheated sludge lagoons or conventional sludge digesters. Research during the past 5 years confirms dependence on anaerobic processes to stabilize agricultural wastes. Major design criteria are: (1) control odors, (2) control fly and mosquito production, (3) prevent infiltration of pond liquor to subsurface natural waters, (4) proper siting for aesthetic purposes. Other important design considerations relate to: volume and depth criteria, summer sludge upwelling requirements and winter sludge submersion requirements, manure inlet location, sludge build-up rates and removal, pond water levels, effluent runoff control, pond geometry and, plant and insect control. (See W70-04761). (D'Arezzo-Texas)
W70-04791

STABILIZATION PONDS IN THE CANNING INDUSTRY,
Federal Water Pollution Control Administration, Washington, D.C.
Robert A. Canham.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 464-476, 2 fig, 2 tab, 25 ref.

Descriptors: *Stabilization, *Ponds, *Solid wastes, *Separation techniques, *Lagoons, *Odors, Efficiencies, Costs, Design standards, Land, Aeration, Bioindicators, Oxygen demand, Enzymes, Anaerobic digestion.
Identifiers: *Canning industry, *Canning waste, *Sodium nitrates, Odor masking agents, Pure or selected cultures, Biocatalyst additives, Anaerobic-aerobic lagoon treatment, Aerated lagoon, National Canners Association.

The canning industry began at the turn of this century to use the lagoon method for waste treatment. However, the industry regarded this method as disposal rather than treatment, and generally this philosophy still prevails. Early lagoons served essentially as absorption areas providing for wastewater infiltration into subsurface waters, subject to the vagaries of soil conditions and waste properties. Later lagoon types served mainly as seasonal waste storage areas. Increasing odor problems led to widespread practice of using sodium nitrate, but results were unsuccessful due to the cost of nitrates and the consequent reduction in quantities used. Lagoon use declined, as other land methods, such as spray irrigation, were introduced. The combination aerobic-anaerobic system was studied, found effective for treatment, but the odor problem remains. The following methods were tested but found inadequate: innoculations with pure cultures, odor masking agents, biocatalyst additives such as enzymes, and aerated lagoons. Operational variations were tried, but the odor problem remained. A more realistic lagoon design and cost approach is essential to make the lagoon method effective for the canning industry. This means greater cost, more land, more chemicals or aeration. (See W70-04761). (D'Arezzo-Texas)
W70-04792

WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
Carter (Ralph B.) Co., Hackensack, N.J.
A. J. Steffen.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 477-491, 5 fig, 2 tab, 1 pl, 21 ref.

Descriptors: *Waste treatment, *History (Meat processing wastes), *Disposal, *Stabilization, *Pre-treatment (Wastes), *Odors, Anaerobic digestion, Lagoons, Tertiary treatment, Pilot plant, Biochemical Oxygen Demand.
Identifiers: *Meat processing industry, *Waste conservation, *By-product recovery, *Disposal by irrigation, *Stabilization basins or lagoons, *Anaerobic ponds (Pre-treatment), *Modified anaerobic contact process, *Aerobic ponds (Complete treatment), Tertiary ponds.

Chemical treatment evoked interest 20-30 years ago, is now limited to pre-treatment achieving only 50-70% BOD removal in current, optimally designed and operated plants. Aerobic treatment such as washable trickling filters have been successful; activated sludge treatment has been effective, but requiring pre-treatment to reduce BOD; aeration systems in concrete tanks and lagoons have been effective for poultry waste treatment; irrigation has been effective for raw meat packing wastes disposal (Illinois and New Zealand) but overall impacts on soil, crops and livestock disease transmission need closer study. Anaerobic ponds are effective as 'roughing' ponds for meat packing wastes because wastes are warm, have high BOD, high organic solid content, and provide proper nutrient balance. Combination aerobic and anaerobic ponds have proved effective. The anaerobic contact process can remove 90-96% BOD in a waste of 1400 mg/l at a digester loading of 0.16 lbs/day/cu. ft, with equalized flow. Digester is a completely mixed system; mixed liquor is degasified by vacuum before gravity separation of sludge which is recirculated to digesters at ratios of 3:1 or 4:1. Process can be closed down on weekends or extended periods without loss of treatment efficiency. By aerobic pond polishing, BOD removal of 80% and suspended solid removal of 88% can be achieved. (See W70-04761). (D-'Arezzo-Texas)
W70-04793

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
Johns Hopkins Univ., Baltimore, Md.; and Louisiana State Univ., Baton Rouge.
Isaiah Gellman, and Herbert F. Berger.
Advances in Water Quality Improvement, (Editors: Gloyna, E. F., and Eckenfelder, W. W., Jr.), Austin, Texas, Univ of Texas Press, 1968. p 492-496, 1 fig, 3 tab, 7 ref.

Descriptors: *Stabilization, *Waste treatment, *Ponds, *Aeration, *Design, *Biochemical Oxygen Demand (BOD), *Odors, Efficiencies, Costs, Construction, Mills, Pilot plants, Retention.
Identifiers: *Waste stabilization ponds, *BOD removal, *BOD loading, *Aerated stabilization ponds, *Pulp and paper industry, Laboratory tests, National Council for Stream Improvement, High-degree effluent treatment, Kraft mills, Chip board mills.

The stabilization pond technique is used predominantly for pulp and paper mill effluents. Data from Southern kraft mill operations indicate that pond design loadings of about 50 lbs of BOD5/acre/day enable at least 85% BOD removal; loadings below 50 lbs provide BOD removals exceeding 90%; increased loadings result in a levelling-off of BOD removals ranging from 60 to 70 lbs/acre/day. Higher BOD removals (up to 150 lbs/acre/day) can be attained using multiple-pond systems; however, high removal operations are accompanied by anaerobic odor production, emission of sulfides, and sulfide oxidizing bacteria. Laboratory and pilot plant studies of aerated stabilization basin process by the National Council for Stream Improvement and its member mills have led to rapid acceptance and extensive application. The aerated basins can remove 40-60 lbs BOD/acre/day, without anaerobic odor production; this correlates well with natural reaeration rates for shallow basins. Construction and operating costs for aerated stabilization pond treatment are about 60% and 40%, respectively, of activated sludge treatment, in the 90% BOD removal range. (See W70-04761). (D-'Arezzo-Texas)
W70-04794

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
Purdue Univ., Lafayette, Ind.
For primary bibliographic entry see Field 05A.
W70-04795

'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
Johns Hopkins Univ., Baltimore, Md.
Jon C. Liebman, and David H. Marks.
Journal of the Sanitary Engineering Division, American Society of Civil Engineers, Vol 94, No SA4, Proc Paper 6059, August 1968. p 585-593, 1 fig, 2 tab, 12 ref.

Descriptors: *Mathematical models, *Optimization, *Cost comparisons, *Pollution abatement, *Water quality control, *Water management, *Treatment, Cost analysis, Treatment facilities.
Identifiers: *'Balas' algorithm, *'Zoned uniform treatment', Cost minimization, Delaware Estuary, BOD removal, Uniform treatment, Fortran IV, IBM 7094 computer.

The basic objective of water-quality management is to find the solution to a pollution abatement problem that achieves a specified quality condition in the watercourse in a legally equitable and economically efficient manner. This problem has been approached in various ways; (1) uniform-treatment schemes in which all discharges into streams are given equal treatment; (2) cost-minimization schemes in which mathematical optimization methods are used to achieve desired quality at minimum treatment costs. Optimization schemes have been resisted because they involve individual local inequities in treatment of discharges even though from a regional viewpoint, quality standards and costs are optimal. A compromise concept called, 'zoned uniform,' is suggested. Concept is based on classifying waste discharges into 'uniform zones' (both geographical and categorical in nature) with each waste source given similar treatment to that of similar sources. Total cost is then minimized as long as treatment level is maintained in each zone. An enumeration scheme solution is presented using Delaware Estuary data. (D'Arezzo-Texas)
W70-04796

PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
Imperial Chemical Industries Ltd., Brixham (England).
P. N. J. Chipperfield.
Journal Water Pollution Control Federation, Vol. 39, p1860-1874, 1967.

Descriptors: Industrial wastes.
Identifiers: *Polyvinyl chloride, *Biological filters, *Textile mill wastes, Dyeing, Fabric finishing.

A plastic filter packing made from polyvinyl chloride was found to be useful as biological filter material in disposal plants handling domestic and industrial wastes, including those from textile mill dyeing and finishing operations. (Work-North Carolina State Univ)
W70-04797

KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
National Institutes of Health, Bethesda, Md.; and Maryland Univ., College Park.
Robert L. Dedrick, and Robert B. Beckmann.
Chemical Engineering Progress Symposium Series No 74, (Physical Adsorption Processes and Principles), Vol 63, 1967. p 68-78, 10 fig, 4 tab, 37 ref.

Descriptors: *Activated carbon, *Adsorption, *Diffusion, *Kinetics, Equilibrium, Isotherms.
Identifiers: *Advanced waste treatment, *Dichlorophenoxyacetic acid, *'Homogeneous diffusion model', *'Pore diffusion model', Concentration, Diffusivity, Intraparticle diffusion.

The removal of small concentrations of dissolved substances from liquids by processes using activated carbon continues to have broad and increasing importance. This study stems from the premise that despite the long history of carbon application, knowledge of kinetics and mechanism of adsorption from liquid solution are incomplete. The two basic mathematical models of intraparticle diffusion kinetics are analyzed: (1) homogeneous diffusion model, (2) pore diffusion model. Tests were made of adsorption of 2-4 dichlorophenoxyacetic acid from dilute solution on carbon such that the rate of transport in the absorbent was controlling, and direct microanalysis of absorbent was made. Authors consider that both models are limiting cases lacking exact precise description of intraparticle diffusion mechanism. The probable mechanism appears to involve both migration of absorbate through the porous carbon with a high energy of activation and diffusion in the adsorbent pores. Surface migration of the homogeneous model appears superimposed on irreversible pore diffusion model effects. (D'Arezzo-Texas)
W70-04798

THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
Canadian Industries Ltd., Montreal (Quebec).
N. E. Cooke.
Canadian Textile Journal, Vol. 81, p39-44, 1964.

Descriptors: *Water pollution, Water quality.
Identifiers: *Textile mill wastes, *Rayon, *Wool, Sizing, Dyeing, Bleaching.

Tables describe the water quality criteria for (1) drinking water, (2) manufacture of viscose rayon, (3) textile manufacture, (4) support of fish and (5) the objectives of the International Joint Commission for Boundry Waters Quality Control. The sources of biological oxygen demand load in textile mill effluents are (1) impurities in the fibers, (2) sizing and other agents needed for weaving, (3) scouring agents, (4) agents for dyeing, bleaching, and printing, and (5) finishing agents. A table presents the ranges of the five classes as related to the processing of natural and man-made fibers. A second table gives details based on two methods of processing wool, showing that a solvent-based process reduces the biological oxygen demand of the waste to one-ninth of that using the traditional wet scour. Generally accepted methods of treating textile mill wastes are reviewed. The principles used in preventing water pollution by the Millhaven, Ontario and Dalhousie, N.B., plants of Canadian Industries, Ltd., and one example of pollution and aeration from the latter are described. (Work-North Carolina State Univ)
W70-04799

LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
Alaska Univ., College.
Sherwood C. Reed, and R. Sage Murphy.
Journal of the Sanitary Engineering Division, American Society Civil Engineering, Vol 95, No SA4, Proc Paper 6747, August 1969. p 747-767, 13 fig, 5 tab, 21 ref.

Descriptors: *Activated sludge, *Settling velocity, *Temperature, *Design, Sewage treatment.
Identifiers: *'Zone-settling', *Activated sludge particle, *Sludge-blanket clarifiers, *Thermal protection, *Sludge, Concentration, Particles, Clarification, Fairbanks (Alas), Stokes' Law, BOD.

This investigation is concerned with the temperature influence upon activated sludge sedimentation theory. Particular attention is focused on temperature effects on 'zone' settling velocity. The study is generated by research results in Alaska on aerated

lagoons and sludge processes which indicated apparent high efficiencies requiring minimal thermal protection. Thus, basically conventional treatment plant designs might be economically adaptable to cold weather regions without costly systems thermal protection. This study presents results of a series of settling tests using temperature and concentration as controlled variables. An empirical equation was developed defining the variations of zone settling velocity of activated sludge in terms of concentration, fluid temperature, and organic loading. Temperature effects diminish with increasing concentration. Equation affords rational basis for analysis of design requirements for cold region treatment facilities. Study concludes tentatively that the compression, or thickening, of sludge is independent of fluid temperature. (D'Arezzo-Texas)
W70-04800

LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Cincinnati Water Research Lab.
M. C. Mulbarger, E. Grossman, III, R. B. Dean, and O. L. Grant.
Journal Water Pollution Control Federation, Vol 41, No 12, p 2070-2085, December 1969. 11 fig, 5 tab, 28 ref, sample calculations.

Descriptors: *Activated sludge, *Dewatering, *Flocculation, *Lime, Phosphorus, Sludge treatment, Wastewater treatment, Slaking.
Identifiers: *Calcination, *Clarification, *Lime reuse, *Lime recovery, *Secondary effluent, *Experimental system, Recarbonation, Thickening, Vacuum filtration.

This investigation, using typical biologically-stabilized effluents, focuses on studying: (1) the effect of wastewater quality on unit process performance; (2) the possible variations of sludge characteristics as functions of the wastewater treatment system; (3) effects of multiple lime reuse on process performance and calcined sludge quality; (4) possible prediction of required lime makeup and sludge wastage rate before start of operations; (5) possible improvement of lime sludge dewatering properties by addition of flocculants. Specifically, a 75-1 day batch system was used to find effects of secondary effluents and the clarification system on: (1) lime dose; (2) clarification effectiveness; (3) sludge thickening; (4) dewatering characteristics; (5) recalcined sludge quantity and quality. Investigation found that lime reuse did not affect removal efficiency, reuse affected sludge thickening slightly but increased greatly dewatered sludge cake yields. Secondary effluent properties greatly affect system performance and lime sludge characteristics. Sludges produced from mineralized waters having low ratios of magnesium hydroxide/calcium carbonate have superior dewatering properties. Of the four additive flocculants studied, a nonionic flocculant proved most effective; the point of addition affected only slightly the sludge filterability. (D-'Arezzo-Texas)
W70-04801

DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
University Coll., London (England).
Francois A. Van Duuren.
Journal of the Sanitary Engineering Division, American Society of Civil Engineers, Vol 94, No SA4, Proc Paper 6076, August 1968. p 671-682, 8 fig, 12 ref.

Descriptors: *Flocculation, *Shear flow, *Laminar flow, Sedimentation, Suspension, Design criteria, Mathematical studies, Bacteria, Hydraulics, Diffusion.
Identifiers: *Flocculator, *Velocity gradient, Coaxial cylinders, Ritchie device, Annulus two-dimensional flow, Flow stability, Centripetal acceleration, Theoretical analysis, Design desiderata, Synchronous electric motor, Couette model flocculator.

Orthokinetic flocculation is the most important engineering process in the removal from water of mineral and biological particles up to the size of bacteria. Flocculation is effected by the collision of particles which occurs when velocity gradients exist within a flow. Hence, the study of flocculation requires devices for which shear in the flow can be determined. With this objective, design criteria are outlined and the theoretical basis given for a velocity gradient flocculator. A coaxial cylinder horizontally-mounted, couette device developed is described. The advantage of horizontal mounting of cylinders is to limit sedimentation. This flocculator can be used to apply a desired velocity gradient to particle suspension in order to study various aspects of flocculation. Device behaves properly hydraulically in that it results in a predominantly two-dimensional flow for a wide range of particle coagulant concentrations. The floc-flow patterns observed in flocculation tests with quartzite particles and alum are described. (Shankar-Texas)
W70-04802

PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
Purdue Univ., Lafayette, Inc.
Joseph T. Ling.
Purdue University, Engineering Bulletin, Extension Series No. 109, p.217-231, 1962.

Descriptors: *Anaerobic digestion, *Lagoons, Solid wastes, Biochemical Oxygen Demand.
Identifiers: *Starch-gluten waste, *Starch-gluten waste treatment, Waste analysis, Protein waste, Starch waste, Carboyhydrate waste, Seeding.

The principal waste involved had a five-day BOD of 12,000 parts per million, consisting of 800 parts per million suspended solids and 15,000 parts per million total solids, of which 14 percent was protein, 7 percent starch, and 79 percent carbohydrate. Of the carbohydrates, 62 percent was reducing sugar. A pilot scale anaerobic digestor was tested during a three-week period. Eighty percent removal of volatile solids was accomplished at a loading of 0.1 lbs. volatile/cu.ft. digestor vol./day. The maximum allowable loading was not reached. Anaerobic lagooning was simulated in 55-gal. drums, and was successful if seeding was included. A minimum of 50 percent removal of volatile solids was observed in seeded lagoons when they were operated at 32-43 deg F. for 11 weeks. The loading applied to the lagoons was 0.022 lbs. volatile solids/cu. ft/day. No objectionable odor was observed in the seeded lagoons within four weeks. Settling of the wastes for 2.5 hrs. was most economical, and this by itself removed 35 percent of the suspended solids. (Livengood-Mattox-North Carolina State Univ)
W70-04803

AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
Battelle Memorial Inst., Richland, Wash.; and Federal Water Pollution Control Administration, Cincinnati, Ohio.
B. W. Mercer, L. L. Ames, C. J. Touhill, W. J. Van Slyke, and R. B. Dean.
Journal Water Pollution Control Federation, Vol 42, No 2, p R95-R107, Feb 1970. 10 fig, 1 tab, 16 ref.

Descriptors: *Ammonia, *Ion exchange, Resins, *Nitrogen, *Separation techniques, Nitrogen compounds, Effluents, Filtration, Zeolites.
Identifiers: *Clinoptilolite, *Laboratory-scale studies, *Nitrogen inorganic compounds, *Pilot-plant studies, Secondary effluents, Regeneration (Engineering), Removal, Elution curves, Zeolite regeneration process, Mobile demonstration plant.

Removal of ammonia from secondary effluent was demonstrated on a laboratory and pilot scale with a selective ion exchange process. Process uses a natural zeiolite, clinoptilolite, which is selective for ammonium ions in the presence of sodium, magnesium and calcium ions. Regeneration is done with lime solutions, providing hydroxyl ions which react with ammonium ions to yield an alkaline aqueous ammonia solution. The solution is processed through an airstripping tower to remove the ammonia. Spent regenerant is fortified with more lime and recycled. The process does not generate liquid wastes. One cubic foot of granular clinoptilolite regenerated with lime can remove ammonia from more than 2,000 gallons of secondary effluent. Ammonia removals of over 99% were obtained for two columns in series during laboratory experiments. A mobile demonstration plant with a 100,000 gallon per day capacity was constructed. (D'Arezzo-Texas)
W70-04804

INVESTIGATION OF A WOOD CURING WASTE,
San Jose State Coll., Calif.
Vernon L. Stump, and Franklin J. Agardy.
Journal of the Sanitary Engineering Division, American Society of Civil Engineers, Vol 95, No SA6, Proc Paper 6953, Dec 1969. p 1051-1061, 6 fig, 14 ref.

Descriptors: *Wood-wastes, *Thermo-dri-process, *Industrial wastes, *Wood preservatives, Chemical oxygen demand, Coagulation, Biochemical oxygen demand, Toxicity, Colloids.
Identifiers: *Vacuum chamber, *Oil separator, *Flotation, Reactor unit, Oxidation ponds, Neutralization, Potential biodegradability.

The investigation of the characteristics of a waste produced by an industry should be carried out prior to or, concurrently with, the design and construction of the waste producing facility. Laboratory studies have been made to determine the characteristics and biological treatability of an industrial waste resulting from a new rapid wood curing process referred to as the Thermo-dri-process. Similarly to most wood preserving wastes, there is a much larger chemical oxygen demand (7500 mg/l) than biochemical oxygen demand (2260 mg/l) for the waste associated with the new wood curing process. The BOD/COD ratio is very low with a value of 0.30. The BOD rate constant of the raw waste to the base e is found to be 0.105, indicating poor biodegradability. The organic fraction of the waste is associated mostly with the suspended colloidal matter of the waste, (90%). The BOD determination is difficult and is affected by the size of the sample. The manometric techniques give a more reliable value. Toxicity studies indicate that the waste has a toxic effect as its concentration with respect to bacterial seed increases. Nutrient studies indicate the need for supplementary nutrients such as nitrogen and phosphorus for optimum biological treatment. (Shankar-Texas)
W70-04805

PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
Federal Water Pollution Control Administration, Cincinnati, Ohio.
E. F. Barth, B. N. Jackson, R. F. Lewis, and R. C. Brenner.
Journal Water Pollution Control Federation, Vol 41, No 11, p 1932-1942, Nov 1969. 6 fig, 9 tab, 5 ref.

Descriptors: *Phosphorus, *Trickling filters, *Efficiencies, *Analytical techniques, *Aluminum, *Nitrogen, Wastewater treatment, Filters (Rock), Suspended load, Effluents.
Identifiers: *Operations, *Aluminates, *Chemical removal, *Wastewater characteristics, Secondary sludge, Volatile content, Primary sludge, Digester gas production, Digester supernatant, Dosages, Trickling filter plant.

Trickling filters containing rock media can be dosed with sodium aluminate to increase phosphorus removal efficiency. Filter operation or biological slime on rock media was not affected adversely. Efficiency of the dosed filter for COD, suspended solids and nitrogen removal was similar to that of the control filter. Direct dosing of rock

mineral supplement is not as efficient for phosphorus removal as adding minerals to an activated aeration chamber. Rock media filters short circuit primary effluents without efficient film surface contact thus reducing quantitatively the conversion of complex phosphates to orthophosphates and further affecting the precipitation reaction. Laminar liquid flow over rock is less efficient than turbulent chamber aeration, insofar as aluminum phosphate contact is concerned. Data shows that doses of aluminum to phosphorus above a ratio of 1:1 does not increase phosphorus removal. Once phosphorus has been insolubilized, the removal efficiency depends on particulate matter delivered to the final clarification in settleable form. Approach is not recommended where high phosphorus removal is needed. (D'Arezzo-Texas)
W70-04806

ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
A. M. Buswell, and R. S. Ingols.
Wastes Engineering, Vol. 33, No. 8, p402-404, 428, 1962.

Descriptors: *Anaerobic digestion, Chemical oxygen demand, Costs.
Identifiers: *De-sizing, *Starch, Cotton mill wastes, Starch esters, Starch gums, Experimentation.

The de-sizing liquors may provide as much as one-half of the biochemical oxygen demand load and only 10% of the liquid effluent from a textile mill. Therefore it may be advisable to treat this concentrated material separately and this can often best be done by anaerobic digestion. Most of the size removed is starch or starch derivates. Laboratory experiments were made on pure solutions of such materials. About 90% of chemical oxygen demand was destroyed in an aerobic digestion with the gas produced being quite variable as compared with the theoretical yield. A capital cost of $40.00 per pound, per day for digesters was estimated. (Work - North Carolina State University)
W70-04807

NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
New Hampshire Univ., Durham.
L. W. Slanetz, T. G. Metcalf, and C. H. Bartley.
New Hampshire Water Resource Research Center Project Completion Report, June 1968, 4 p. OWRR A-007-NH.

Descriptors: *Microorganisms, *Stabilization, *Ponds, *Effluents, Sewage, Coliforms, Streptococcus, Salmonella, Viruses, Bacteria, Organic matter, Indicators, Temperature, Pseudomonas, Seasonal, Water pollution.
Identifiers: Enteric, Survival rates, Flavobacter, Achromobacter, Kurthia, Antibiotics, Health, Indicator bacteria, Stabilization ponds.

Objective was to determine number and type of microorganisms in stabilization pond effluents compared to those present in raw sewage. Numbers and survival of coliforms, fecal coliforms, fecal streptococci, salmonellae, and enteroviruses in raw sewage and in stabilization pond effluents were determined in two community systems, the first containing three ponds and the second, four ponds, both receiving domestic waste. Survival rates for the indicator bacteria from pond effluents were obtained for both systems. Die-off rates were greater in summer than during winter. Salmonellae and enteric viruses were isolated from the majority of effluent samples tested from the first system, and, from the second system, Salmonellae were isolated from 19 out of 33 samples of raw sewage; and enteric viruses from 10 out of 10 Pond 4 effluent samples. The genera Flavobacter, Achromobacter and Pseudomonas were found to be the predominant bacteria that became established and grew in the pond systems. Filtrates from these organisms showed no antibiotic action against coliforms and fecal streptococci. Antibiotic activity against these organisms was demonstrated by the infrequent isolation of bacteria in the genus Kurthia. (Jones-Wisconsin)
W70-04819

TEXTILE WORKS EFFLUENT TREATMENT,
A. H. Little.
Textile Institute and Industries, Vol. 1, p9-11, 1963.

Descriptors: *Legislation, *Cost analysis, *Water pollution control, Pollution abatement, Waste waters, Waste water treatment, Waste disposal, Surface waters.
Identifiers: *Effluent treatment.

The author discusses the effect of recent British legislation concerning pollution on the textile industry, and indicates typical requirements for the discharge of waste waters to municipal sewers and to surface waters. He outlines possible methods of treatment for textile waste waters and indicates some of the costs of treatment and disposal. (Livengood-Mattox, North Carolina State University)
W70-04831

WASTE WATER CONTROL SYMPOSIUM.

American Dyestuff Reporter, Vol. 51, No. 10, p 358-364, 1962.

Descriptors: *Chemical wastes, *Domestic wastes, *Water pollution control, *Water conservation, Waste treatment, Biochemical oxygen demand, Fish, Toxicity, Waste treatment, Trickling filters, Biodegradation, Detergents.
Identifiers: *Dyeing wastes, *Slashing wastes, Starch, Sizes (Slashing), Sodium carboxymethylcellulose.

The Papers relating to textile wastes include: I. Factors causing pollution of rivers by wastes from the textile industry. II. The feasibility of treating textile wastes in connection with domestic sewage. III. Problems of textile chemical wastes. IV. Waste water control and water conservation. (See also W70-04850 thru W70-04853). (Livengood-North Carolina State Univ)
W70-04849

I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
Georgia Inst. of Tech., Atlanta. School of Applied Biology.
Robert S. Ingols.
American Dyestuff Reporter, Vol. 51, No. 10, p 358-359, 1962.

Descriptors: *Biochemical oxidation demand, *Chemical wastes, *Toxidity, *Turbidity, Temperature.
Identifiers: *pH, Sodium hydroxide, Starch, Sizes (Slashing), Carboxymethycellulose.

Pollution is defined as the degradation of water quality as result of mans' use which affects adversely the user of the water downstream. The factors causing pollution include BOD, certain 'inert' organic molecules, high pH values, toxic chemicals, color, turbidity and/or elevated temperatures. (See W70-04849). (Robinson-North Carolina State Univ)
W70-04850

II. THE FEASIBILITY OF TREATING TEXTILE WASTES IN CONNECTION WITH DOMESTIC SEWAGE,
Robert D. Wilroy.
American Dyestuff Reporter, Vol. 51, No. 10, p 360-362, 1962.

Descriptors: *Domestic wastes, *Waste treatment, Trickling filters, Activated sludge.
Identifiers: Bleaching wastes, Starch, Scouring waste.

The trickling filter or activated sludge unit is an aerobic process, and the sludge digestion process is an anaerobic process. This difference in the processes had a definite bearing on the treatment of the various textile wastes when they are added to a sanitary sewer system. Each waste must be considered in relationship to its characteristics and the relative amount of sanitary wastes for which it can be treated. Pilot-plant studies are generally required with most large volumes to see if the waste can be treated with the sanitary wastes and to develop the necessary design information to do an adequate job. The sewer systems in several cities (Dalton, Georgia; LaGrange, Georgia; Greenville, South Carolina; and Lebanon, Tennessee) which combine textile and industrial wastes are discussed. (See W70-04849). (Robinson-North Carolina State Univ)
W70-04851

III. PROBLEMS OF TEXTILE CHEMICAL WASTES,
Charles Starling.
American Dyestuff Reporter, Vol. 51, No. 10, p 362-363, 1962.

Descriptors: Detergents, Biochemical oxidation demand.
Identifiers: *Biodegradability.

When a waste component exerts a BOD, it is converted to the oxygen equivalent of carbon dioxide, animal protoplasm or vegetable cells, and the problem is through and done when the BOD is satisfied either in a treatment works or in the natural course of the stream travel. When the soluble component of the waste exerts no BOD it stays in its carrier indefinitely. The problem then becomes what concentration of these indestructable wastes can be tolerated in streams and how far are we justified in attempting to solve our waste problems by substituting indestructable materials for those which are destroyed by biochemical oxidation. The best interest of streams are wastes which are 100% biodegradable. The problem of textile chemicals in wastes contains many variables and unknowns. Manufactures of textile chemical specialties should have a primary responsibility in developing new and more biodegradable products. (See W70-04849). (Robinson-North Carolina State Univ)
W70-04852

IV. WASTE WATER CONTROL AND WATER CONSERVATION,
R. Hobart Souther.
American Dyestuff Reporter, Vol. 51, No. 10, p 363-364, 1962.

Descriptors: *Water conservation, Control.
Identifiers: Bio-aeration.

Progress in pollution abatement in the past has been handicapped by the relatively high cost of treatment, due partly to use of outmoded conventional processes. Wet-processing industries in the United States have contributed more in research toward cleaning up streams than governmental agencies. Since capital and operational costs of new types of waste treatment plants are much lower than conventional trickling filter or activated sludge plants, other industrial groups and cities treating industrial waste may be expected to follow with low cost bio-aeration plants. (See W70-04849). (Robinson-North Carolina State Univ)
W70-04853

TREATMENT OF INDUSTRIAL WASTE WATERS IN THE UNITED STATES,
H. H. Black.
Bulletin Mensuel, Centre Belge d'Etude et de Documentation des Eaux, Liege, Belgium, Vol. 34, No. 71, p 246-262, 1956.

Descriptors: *Waste water treatment, Oil wastes, Treatment facilities.
Identifiers: *Textile wastes, Food processing wastes.

Descriptions are given of the treatment in the United States of America of waste waters from oil refineries, motor car manufacture, milk trade, food processing, textile industry. Flow diagrams and photographs of some of the plants are given. (Livengood-North Carolina State Univ)
W70-04895

NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
Texas Univ., Austin. Environmental Health Engineering Research Lab.
S. Balakrishnan, and W. W. Eckenfelder.
Water Research (J Int Assn on Wat Pol Res), Vol 3, No 1, pp 73-81, January 1969. 7 fig, 4 tab, 11 ref.

Descriptors: *Nitrification, *Activated sludge, *Organic loading, Aeration.
Identifiers: *C:N ratio, Rate constants, Raw sewage, Mixed liquor, Loading factor, BOD, COD, Kjeldahl nitrogen, Synthetic wastewater, MLSS.

This is the first in a series of three articles. The second is similar to this but on the trickling filter and the third is on denitrification. The authors found complete nitrification when the organic loading factor did not exceed 0.3-0.4, provided the other conditions were optimal. There is a minimum sludge age of 3 to 4 days for good nitrification at 23 deg C. The nitrification increased with an increase in the ammonia applied, but the increase in nitrification was at a slower rate than that for the ammonia. Batch runs indicated that nitrification can be formulated by both the autocatalytic and first order reactions. Complete nitrification of the final effluent is obtained by an aeration period of 8 hrs at a MLSS concentration of 2800 mg/l. Oxygen demand of the mixed liquor ranged within 10 percent of the theoretical requirements for both nitrification and BOD removal. (Ledbetter-Texas)
W70-04896

NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
New Zealand Wool Industries Research Inst., Inc., Dunedin.
J. L. Hoare, R. G. Stewart, and B. J. Sweetman.
New Zealand Journal of Science, Vol. 12, No. 2, p 237-251, 1969. 33 ref, 4 tab, 2 fig.

Descriptors: *Potassium compounds, Domestic wastes, Laboratory tests.
Identifiers: *Wool scouring, *Wool grease, Acid cracking.

Laboratory investigations were made of commercial wool scouring waste liquids to determine the amount of potassium salts present and recover them and also methods of acid cracking to cause wool grease to separate from the water solution. It was concluded that the recovery of potassium salts could not be economically justified. Hard cracking alone produces poor phase separation and the process would require additional chemical or other method of flocculation. It is felt that the most satisfactory method of treatment of wool scouring waste is in conjunction with domestic wastes in conventional sewage treatment plants. (Work-North Carolina State Univ)
W70-04897

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
Oak Ridge National Lab., Tenn.
For primary bibliographic entry see Field 03A.
W70-04930

WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
Cluett, Peabody Co., Inc., New York.
R. H. Souther.
American Dyestuff Reporter, Vol. 58, No. 15, p 13-16, 1969. 4 tab, 6 ref.

Descriptors: Hudson River, Biochemical Oxygen Demand, Alkalinity.
Identifiers: *Textile finishing plant, *Mercerizing, *Caustic soda, *Caustic recovery, Mohawk River, Desizing, Scouring, Bleaching, Fabric, Textile mill wastes.

A textile finishing plant, located at the confluence of the Mohawk and Hudson rivers, had potential pollutants resulting from natural impurities on fabrics and from the processing chemicals used in the desizing, scouring, mercerizing, bleaching and finishing operations. Installation of caustic soda recovery units eliminated hydroxyl alkalinity and reduced pollution loading by about 50%. They made it possible to remove 97% of BOD from the effluent water, as compared with about 65% efficiency obtainable with the previous highly alkaline effluent. Tank sizes and retention times in the bio-aeration process were reduced. It was felt that the installation of a filter plant and ion-exchanger would make it possible to recirculate water. (Work-North Carolina State University)
W70-04945

ECONOMICS OF RECLAIMED WATER IN DYEWORKS.

International Dyer, Vol. 141, No. 5, p303-304, 1969.

Descriptors: *Activated carbon, *Water reuse.
Identifiers: *Carpet mill wastes, Dyestuffs, *Dyehouse wastes.

A bed of activated carbon is used to absorb dyestuffs from the 500,000 gal/day of effluent water from the dyehouse of a carpet mill, after which the water is reused. The carbon is on a moving bed and is regenerated by high temperature treatment as often as is required by the loading rate. (Work-North Carolina State University)
W70-04946

CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
Tingey-Moss Ltd.
G. I. Hollings, and J. Ruddy.
The Textile Institute and Industry, January 1970, p12-15, 5 tab, 2 fig.
Identifiers: *Dyehouse wastes, *Solvent scouring, Textile mill wastes, Starch, Warp sizes, Sizing wastes.

The use of solvent scouring to replace conventional systems completely eliminates the problem of disposing of highly alkaline wash liquors. A small amount of water is required to remove accumulations of sizing on the equipment, the sizing having been reduced from about 10% to 2 to 4% in the solvent process. Aqueous scouring, following the solvent scouring, may be required to remove those residual amounts of starch sizes from fabrics based upon cotton or cotton blends. (Work-North Carolina State University)
W70-04960

BIOLOGICAL TREATMENT SOLVES DYEWORKS EFFLUENT PROBLEMS,
J. E. Felstead.
Water and Waste Treatment Journal, Vol. 11, p127-129, 1966.

Descriptors: *Activated sludge, Detergents, Biochemical oxygen demand.
Identifiers: *Dyehouse wastes, *Dyes, Nylon.

Treatment facilties were developed for waste waters from the textile dyeing and finishing plant of Joshua Wardle Ltd. at Lee, England. This involved preliminary chemical analyses of minor effluents and laboratory-scale trials on composite effluents. The waste waters were formerly passed over alumina ferric blocks and settled before discharge but the effluent failed to comply with the standards laid down by the Trent River Authority. The waste waters from the 2 mills, in nature mainly organic, but also containing low concentrations of a variety of other compounds such as inorganic salts and bases, are now pumped first to a holding tank, and then to 2 activated-sludge tanks fitted with Simcar aerators. After secondary sedimentation, the final effluent is discharged to the river Churnett, a tributary of the river Dove. (Work-North Carolina State University)
W70-04961

SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
K. R. Dietrich.
Textil-Praxis, Vol. 22, No. 2, p126-127, 1967. 1 tab, 5 ref.

Descriptors: *Flocculation, Iron compounds, Calcium compounds, Biochemical oxygen demand, *Phosphorus compounds, Chemical precipitation.
Identifiers: *Textile mill wastes, *Precipitation, Silicon compounds, Dyes, Aluminum compounds.

Mixtures of electrolytes containing Al3+, Fe3+, Fe++, Si4+, and Ca++ are more effective flocculating agents than those containing only Fe3+ cations. Applied to textile plant sewage at <50mg./l., the mixtures drastically reduce the organic matter, ppt. or absorb dyes and P compounds, and improve the drying of the sludge; the effects are largely independent of pH. Thus, in 1 case, the treatment reduced the BOD from 215 to 25 mg. 0/1. and the KMnO4 consumption from 1005 to 320 mg./l., while the pH changed from 7.5 to 6.8 and the settling solids from 20 to 175 mg./l. This obviates further pH adjustment, rock filtration, or ion exchange treatment. (Work-Livengood-North Carolina State University)
W70-04962

PROBLEMS OF EFFLUENT DISPOSAL,
Spence (Peter) and Sons Ltd., Widnes (England).
J. H. Harwood.
Textile Manufacturer, Vol. 89, p33-34, 1963.

Descriptors: *Sewers, Sedimentation, Biological treatment, Aeration, Neutralization, Chemical precipitation, Sludge disposal, Filtration.
Identifiers: *Effluent disposal, *Dyehouse wastes, Dyeing wastes, Finishing wastes, Balancing tanks, pH control, Segregation, Screening, Chemical oxidation, Biological oxidation.

The most acceptable solution for industralists is to have their effluent accepted into public sewage systems whenever possible. Costs would be lower than for construction and operation of individual plants. The minimal equipment at a treatment plant consists of balancing tanks, pH adjustment, and sedimentation equipment. If wastes are discharged into streams, biological treatment may also be necessary. Where several types of treatment are carried out on the same site, adequate mixing is essential. Any or all of the following items may be needed: (a) segregation of wastes, (b) balancing and storing, (c) screening, (d) aeration, (e) neutralization, (f) chemical precipitation, (g) chemical oxidation, (h) filtration, (i) biological oxidation, (j) sludge disposal. (Robinson-North Carolina State University)
W70-04963

TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
Canton Textiles, Inc.
L. L. Jones, Jr.
Journal of Water Pollution Control Federation, Vol 37, No 12, p 1693-1695, 1965.

Descriptors: Dissolved oxygen, Biochemical oxidation demand, Solid wastes, Color.
Identifiers: *Biological aeration, *Starch wastes, *Dyeing wastes, *Dyehouse wastes, Biological waste tank.

The prolonged biological aeration method was chosen for use at this plant. Starch wastes, with high biochemical oxidation demand and low volume, are desirable as nutrients for microorganisms. Dye house wastes constitute a majority of wastes and are the most varied types. The biological oxidation process gives satisfactory treatment of sewage and mill wastes with an efficiency of removal of biological oxidation demand of 90% after 20 hours aeration. The process is described, and descriptions of equipment, costs, and comparisons of influent and effluent are given. (Robinson-North Carolina State Univ)
W70-04964

THE TREATMENT OF STRONG INDUSTRIAL WASTES ON THE CONTINENT,
M. Kehren.
Ciba Review, No 121, p 25-27, 1957.

Descriptors: *Chemical precipitation, *Biological treatment.
Identifiers: Niers process, Sedimentation tanks.

The normal sequence of treatment is a combination of wastes in (a) central sedimentation tank, (b) chemical precipitation followed by settling, (c) biological treatment after waste has passed through a secondary settling tank, and (d) removal of biological sludge in a third settling tank. The Niers process is described. (Robinson-North Carolina State Univ)
W70-04965

FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
M. Kehren.
Ciba Review, No 121, p 22-24, 1957.

Descriptors: *Chemical precipitation.
Identifiers: *Iron salts, *Ferrous compounds, *Basic dyes, *Acid dyes, *Direct dyes, *Vat dyes, *Sulphur dyes, *Developed dyes, Ferrous sulphate, Ferric chloride, Ferric compounds, Dyehouse wastes.

The approved forms of iron available for application to wastes are as follows: (1) Iron metal turnings and (2) Iron salts (ferrous sulphate, chlorinated copperas, ferric chloride). Systematic treatment of waters containing dyestuffs with iron or iron salts has led to the following conclusions: (1) Treatment with iron salts needs less iron than application of elementary iron. (2) Ferrous compounds are less economical of iron than ferric. (3) With optimum clarifications, divalent iron remains partly unflocculated in the settled liquid and requires after-flocculation. (4) Coagulation is most effective in the pH range of 5.5-6.1. (5) Around the isoelectric point, low concentration of dyestuffs requires relatively large amounts of iron for their removal. (6) In the alkaline range, no clarification occurs if the iron and dye concentrations are between 20 and 100 p.p.m., though considerable iron flocculation takes place. (7) In the strongly acidic range, a given concentration of iron coagulates large amounts of dye, while an increasing proportion of iron remains unflocculated. (8) The dye concentrations most economical of iron range from 100-150 p.p.m. The treatments for basic dyes, acid dyes, direct dyes, vat dyes, sulphur dyes, and developed dyes are described.
W70-04966

TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
Agricultural Research Service, Albany, Calif. Western Utilization Research and Development Div.
W. Fong, and H. P. Lundgren.
Textile Research Journal, Vol 25, p 994-1000, 1955.

Descriptors: *Bentonile, Chemical oxygen demand.
Identifiers: *Wool, *Wool-scouring wastes, Wool grease, Suint, Scouring wastes, Acid-cracking process, Centrifugal process.

A dispersible-type bentonite produces a marked improvement in the extent of clarification of the waste effluent from the conventional acid cracking of wool. The scouring wastes are acidified with sulfuric acid to a pH level between 3 and 4 and then the required amount of bentonite is added as an aqueous dispersion. The amount of waste between 0.1 and 0.5% is generally sufficient. Treatment of a standard waste with acid and bentonite removed as much as 96% of the grease compared with removal of 67% with acid alone. The chemical oxygen demand was reduced by approximately 60% by the combination treatment, compared with 33% reduction with acid alone. (Work-North Carolina State Univ)
W70-04967

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
M. Kehren.
Ciba Review, No 121, p 13-22, 1957.

Descriptors: *Percolation, *Trickling filters, *Activated sludge, *Sludge treatment, *Chemical precipitation.
Identifiers: *Clarifiers, *Settling tanks, *Biological purification, *Spray irrigation.

The following treatment methods are described: clarifiers and settling tanks, percolation, biological purification, trickling filters, activated sludge process, sludge treatment, spray irrigation, and chemical precipitation. (Robinson-North Carolina State Univ)
W70-04968

THE PROBLEM OF WASTE WATER TREATMENT,
M. Kehren.
Ciba Review, No 121, p 4-7, 1957.

Descriptors: *Self-purification.
Identifiers: Oxygen depletion.

In biological self-purification, bacteria oxidize or reduce wastes aerobically or anaerobically. Too much load on a stream will upset its recuperative power, and continuous oxygen depletion causes extinction of practically all living matter in water. Photomicrographs of protozoa which oxidize or reduce wastes are included. (Robinson-North Carolina State Univ)
W70-04970

SOME DIFFERENCES BETWEEN BRITISH, AMERICAN, AND CONTINENTAL PRACTICE,
L. Klein.
Ciba Review, No 121, p 3, 1957.

Descriptors: *Biological treatment, *Analytical treatment.

Most of the methods are similar. American industries are more willing to pay for waste treatment. Biological treatment is more common in Great Britain and on the Continent. The small size of British rivers requires a higher degree of treatment. Chemical tests are all similar. (Robinson-North Carolina State Univ)
W70-04971

POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
J. W. Masseli, and M. G. Burford.
Sewage and Industrial Wastes, Vol 26, p 1109-1116, 1954.

Descriptors: *Pollution abatement, *Water pollution sources, Effluents, Biochemical oxygen demand, Soaps, Data collections.
Identifiers: *Cotton finishing wastes, *Substitute chemicals, *Scouring waste, *Desizing wastes, Process chemicals, Starch, Cotton waxes, Pectins, Cellulose ethers.

Results of an effluent survey of a cotton finishing plant were compared with data derived from an inventory of the BOD values of process chemicals used. The former indicated a discharge of 123 pounds and the latter 155 pounds BOD per 1,000 pounds of cloth. Process chemicals were shown to contribute 70-80% of the total BOD with starch, soap, and ACOH the major sources; 20-30% of the BOD was attributed to the natural waxes and pectins extracted from the cotton fiber during scouring. The possibilities are indicated of pollution reductions of 50-75% by substitution of low BOD chemicals for those now used; cellulose ethers for starch. Desizing and scouring contribute 35 and 32% of the total BOD, respectively. (Mattox, Livengood-North Carolina State Univ)
W70-04972

SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
Laporte Chemicals Ltd., Luton (England).
L. Chesner, and F. W. Roberts.
Textile Institute and Industry, Vol 1, No 5, p 10-12, 1963. 6 tab.

Descriptors: Biochemical oxygen demand, Domestic wastes.
Identifiers: *Textile mill wastes, *Bleaching plant wastes, *Caustic, Kier processing, Starch desizing, Scouring, Bleaching, Sodium hypochlorite, Cotton, Cotton impurities, Hydrogen peroxide, Peracetic acid, Percolating filters.

Table 1 presents numerical data on the BOD of chemicals used in the textile industry. Table 2 gives the 'population equivalent' per weight of fabric processed. Table 3 presents data for BOD per weight of fabric in selected wet-processing operations. Table 4 analyses waste liquids from caustic scour and bleaching. Table 5 gives the properties of waste water from kiering (scour and bleach). Table 6 is an analysis of effluents from percolating filters processing the waste water in Table 5. The conclusion is made that caustic kier waste water can be purified to the 80-90% level of its first neutralized and if nitrogen is made available either by chemical addition or by mixture with domestic sewage. (Work-NorthCarolina State Univ)
W70-04973

APPLICATION OF CHLORINE AND TREATMENT OF TEXTILES WASTES,
Wallace and Tierman, Inc., Belleville, N.J.
N. S. Chamberlain.
Proceedings of the Third Southern Municipal Industrial Waste Conference, Raleigh, North Carolina, p 176-189, 1954.

Descriptors: Lime, Chlorine, Chemical precipitation.
Identifiers: *Textile mill wastes, *Coagulating, Chemical treatments, Ferrous sulfate, Sulfuric acid.

There is a diversity of waste products from textile mills and therefore, in order to secure coagulation of wastes, the chemistry of these must be known. Batch processes may be preferred, especially where individual chemical wastes can be used to destroy each other. The preferred chemicals to assist coagulation and precipitation of solids are ferrous sulfate, lime and sulfuric acid. Chlorine can be used both for this purpose and to purify effluent waters. (Work-North Carolina State Univ)
W70-04974

PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
Camp, Dresser, and McKee, Boston, Mass.
R. H. Culver.
Journal Boston Society Civil Engineers, Vol 45, p 227-248, 1967. 8 fig, 3 tab.

Descriptors: *Biochemical oxygen demand, Biological treatment, *Trickling filters, Vat dyes, Activated sludge.
Identifiers: *Textile mill wastes.

Before designing a new treatment plant to handle about 11 m.g.d., of which about 40 percent is textile waste, pilot-plant studies were carried out on treatment of the mixed sewage and waste waters by various biological methods. It was concluded that an effluent with a BOD of about 50 mg/l. could be obtained by two-stage biological treatment if the pH value of the influent was reduced to less than 9.5. This can be achieved by treatment with flue gas. First-stage biological treatment on a percolating filter operating with recirculation stabilizes the system and prevents shock loads affecting the subsequent activated-sludge process. The suspended solids in the mixed liquor from the activated-sludge units settle only slowly and coagulation before final sedimentation is necessary to give a well-clarified effluent. About 80 percent of the indigo dye in the waste waters is adsorbed on the biological flocs during treatment. The amount of sludge produced is too small to be used as a source of gas for power production, and therefore the process should be operated so as to produce a minimum quantity of sludge. (Work-North Carolina State Univ)
W70-04975

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
Spence (Peter) and Sons Ltd., Widnes (England).
J. H. Harwood.
Journal of the Society of Dyers and Colourists, Vol 77, No 11, p 537-543, 1961.

Descriptors: *Legislation, *Sedimentation, Coagulation, Biological ttreatment, Neutralization, Lime, Anaerobic digestion, Sludge treatment.
Identifiers: *Dyehouse wastes, Effluent disposal, Waste treatment plant, Balancing tanks, pH control, Kestner neutralizer, Sedimentation tanks, Aluminum sulphate, Unifloc process, Aluminum lakes, Sodium hypochlorite, Dyes, Textile mill wastes.

The legal position affecting the disposal of trade effluent in sewers, rivers, and estuaries is reviewed. The major portion of the report deals with various treatment processes. The minimum equipment necessary to treat a normal works' effluent consists of balancing tanks and pH adjustment, and sedimentation equipment. The three general types of tanks used are horizontal flow, upward flow, and radial flow. The major types of sedimentation plants are those which use solid reagents, fill-and-draw units, and continuous-flow units. The least expensive method of sludge disposal is to pump the sludge onto the ground and allow it to dry. Many dyes may be decomposed by anaerobic treatment. Paper mill wastes are best disposed of by addition of coagulants before sedimentation. For tannery effluents, chemcial precipitation can reduce the load on biological filters by one-half. Unless the effluent is discharged to a domestic sewer, coagulation is not sufficient. Highly colored dyehouse and textile wastes are successfully treated by formation of aluminum lakes. Soluble dyes can be removed by sodium hypochlorite treatment. (Robinson-North Carolina State Univ)
W70-04976

DEVELOPMENTS AND EQUIPMENT IN EFFLUENT TREATMENT,
J. G. Kennedy.
International Dyer, Textile Printer, Bleaches and Finishes, Vol 133, No 12, p 939-947, 1965. 3 diagrams.

Descriptors: *Sewers, Calcium chloride, Waste treatment, Pilot plants, Sludge treatment.
Identifiers: *Wool grease, *Viscose rayon, Fiber production wastes (Synthetics), Textile wastes, Scouring, Biological purification, Physiochemical purification.

One solution to the treatment problem is that industrial wastes may be partially treated before dumping them into municipal sewers, or the wastes may be dumped directly into the sewers. Where a large capital sum is involved or an unknown type of effluent is to be treated, pilot plants are generally erected before embarking on the main scheme. The separation of wool grease by precipitation with calcium chloride is discussed. Methods employed to prevent pollution of the Danube by viscose manufacturing waste are mentioned. An example of the treatment of effluents from a dye manufacturing plant is also given. Two of the newer processes for treatment are the Water Engineering, Ltd., three-stage process which is a complete effluent treatment process suitable for chemical and food industries and stringe discharge filters developed by Stockdale Engineering, Ltd. In summation, the wastes from every plant are different and therefore the type of process chosen depends on the type of waste, amount of waste, and requirements by local authorities. (Robinson-North Carolina State Univ)
W70-04977

AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
Battelle Memorial Inst., Richland, Wash. Pacific Northwest Labs.

Available from the Clearinghouse as PB-187 759, $3.00 in paper copy, $0.65 in microfiche. FWPCA, Ohio Basin Region, Robert A. Taft Sanitary Engineering Ctr, Report TWRC-5, March 1969. 58 p. Grant WPRD 26-01.

Descriptors: *Ammonia, *Ion exchange, Calcium, Silicates, Wastewater treatment, *Farm wastes, Nitrogen, *Zeolites.
Identifiers: *Clinoptilolite, Strippers, Ammonia removal.

A selective ion exchange process was developed for removal of ammonia nitrogen from wastewater. The process employs a natural zeolite, clinoptilolite, which is selective for ammonium ions in the presnece of sodium, magnesium, and calcium ions. Regeneration of the exhausted clinoptilolite is accomplished with solutions or slurries containing lime. Lime provides hydroxyl ions which react with the ammonium ions to yield an alkaline aqueous ammonia solution. This ammonia solution is processed through an air stripping tower to remove the ammonia which is exhausted harmlessly to the atmosphere. The spent regenerant is then fortified with more lime and recycled to the zeolite bed to remove more ammonia. Since the regenerant is not discarded, the process generates no liquid wastes. The ion exchange equilibria of four zeolites was investigated and clinoptilolite was selected for further study on the basis of its ammonium ion selectively and low cost. Operation of the mobile plant with secondary effluent resulted in ammonia removals of 97 and 93 percent at 70,000 and 100,000 gallons per day respectively; thus demonstrating that selective ion exchange provides a highly effective means for removing ammonia from wastewater.
W70-04982

5E. Ultimate Disposal of Wastes

DISPOSAL OF BRINE BY SOLAR EVAPORATION: LABORATORY EXPERIMENTS,
New Mexico State Univ., University Park.
C. G. Keyes, Jr., D. C. Winans, C. Morales, H. R. Pritchett, and W. S. Gregory.
Office of Saline Water, Research and Development Progress Report No. 548, April 1970. 152 p. OSW Contract 14-01-0001-969.

Descriptors: *Brine disposal, *Evaporation, *Energy balance, *Evaporation pans, *Laboratory tests.
Identifiers: *Evaporation enhancement, *Dyes.

An experimental study was carried out to determine the effects of wind, temperature, solar radiation, water depth and dyes on the evaporation rate of brine solutions. Naphthol Green dye decreased the evaporation of a 12% brine solution in most cases (depths from 0.25 to 1.5 feet), except at the 1.25 foot depth; i.e., the optimum evaporation depth for the brine with Naphthol Green. It was also observed that evaporation decreased as the concentration increased except around the 12.4% brine level. The upper (17.4%) and lower (0.3%) concentrations produced a different response for temperature and saturation vapor pressure. As radiation increased to a peak value then decreased one value, there was a radiation value which produced a minimum amount of evaporation. This same effect occurred for the saturation vapor pressure and the bulk temperatures.
W70-04891

DISPOSAL OF BRINE BY SOLAR EVAPORATION: DATA,
New Mexico State Univ., University Park.
C. G. Keyes, Jr., N. N. Gunaji, J. V. Lunsford, J. G. Seckler, and O. D. Richard.
Office of Saline Water Research and Develop. Progress Report No. 547, April 1970. 154 p. OSW Contract 14-01-0001-969.

Descriptors: *Brine disposal, *Evaporation, *Energy balance, *Mathematical models, *Computer models, Solar radiation, Heat balance, Heat budget.
Identifiers: *Evaporation rates, Brine evaporation, Theoretical studies.

The disposal of brine by means of solar evaporation has been extensively studied in many arid and semi-arid regions. Efforts to accelerate the evaporation rate have also been made in order to utilize solar methods in areas where the net evaporation is relatively low. The experimental program consisted of studying the effect of Bismark Brown, Congo Red, Methylene Blue, Naphthol Green and Nigrosine Dyes on the solar evaporation of brine. To evaluate the effect of dye on the solar evaporation of brine, three basic methods were employed: (1) Mass Transfer, (2) Energy Budget, and (3) Water Budget. The results of this report consists only of the data furnished to the computer.
W70-04892

5F. Water Treatment and Quality Alteration

UNDER THE RUG,
Colorado School of Mines, Golden. Mineral Resources Inst.
For primary bibliographic entry see Field 05G.
W70-04589

5G. Water Quality Control

DESALTING CALIFORNIA,
California State Dept. of Public Health, Sacramento. Environmental Sanitation Div.
Frank M. Stead.
Environment, Vol 11, No 8, p 2-10, June 1969. 9 p, 5 photo, 1 map.

Descriptors: *Drainage systems, *Drainage water, *Return flow, *Irrigation programs, *California, Diversion loss returns, Water pollution sources, Nutrients, Saline water.
Identifiers: Central Valley (California).

California's Central Valley, one of the most productive farming areas in the world, suffers salt accumulation from irrigation water residues. A master drain is proposed to remove saline irrigation waste water. No safe discharge point can be found. The proposed drain would be the sole drainage outlet for lands soon to be irrigated by the California Aqueduct, and would also serve those presently irrigated lands where excess salt in the soil profile or high water tables currently threaten the production of high crop yields. The central concern is that the

discharge of water from the drain would have a disastrous impact upon the ecology of the San Francisco Bay and the delta systems as a result of nutrients, pesticides and salts in the drainage water. Evaporation, desalination and reuse of waste waters and nutrients are proposed as an alternative to export. (Knapp-USGS)
W70-04583

UNDER THE RUG,
Colorado School of Mines, Golden. Mineral Resources Inst.
David M. Evans, and Albert Bradford.
Environment, Vol 11, No 8, p 3-13, 31, October 1969. 12 p, 6 fig, 1 tab, 29 ref.

Descriptors: *Waste disposal, *Injection wells, *Aquifers, Industrial wastes, Recharge, Corrosion, Public health, Safety, Water pollution sources, Water pollution effects, Earthquakes, Water pressure.
Identifiers: *Waste disposal wells.

Legislative control of underground waste disposal, the techniques of disposal, and possible effects of the use of disposal wells are reviewed. Few states regulate in any specific way what substances go underground. Many industries and government agencies are taking advantage of this gap in control laws and are now dumping their toxic wastes below the ground through deep injection wells. Such wells are usually cheap to build and operate compared with the cost of cleaning up wastes or storing them, but they offer only temporary safety from the many permanently toxic wastes being injected. The industrial wastes going down deep wells range from steroids and photographic chemicals to uranium tailings. At the Rocky Mountain Arsenal in Denver, wastes from the manufacture of poison gas had been dumped into above-ground holding ponds since 1943. A month after injection began, Denver had its first earthquake in 80 years, and in November 1965, the 710 Denver earthquakes recorded by that time correlated with the volumes of fluid pumped into the Arsenal well. Discontinuation of many wells in service and very careful study of the need and desirability of any new wells are recommended. In general, treatment for nonpolluting surface disposal of industrial wastes is safer and more desirable than underground disposal of raw or dangerous wastes. (Knapp-USGS)
W70-04589

CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
Technion-Israel Inst. of Tech., Haifa. Sanitary Engineering Lab.; and Agricultural Research Service, Bushland, Tex. Southern Plains Branch.
For primary bibliographic entry see Field 04B.
W70-04609

COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (An Engineering-Economic Approach to Evaluate the Extent and Magnitude of the Complementary and Competitive Aspects of Water Storage for Water Quality Control),
Sacramento State Coll., Calif. Dept. of Civil Engineering.
Kenneth D. Kerri.
Available from the Clearinghouse as PB-190 197, $3.00 in paper copy, $0.65 in microfiche. Water Pollution Control Research Series DAST-1, Dec, 1969. 190 p, 6 tab, 10 fig, 37 ref, 5 append. FWPCA Program No. 16090DEA---12/69.

Descriptors: *Allocation, *Flow Augmentation, Marginal analysis, Planning, *Reservoir operation, *Simulation, Temperature control, Water pollution, Water quality.

Allocation of scarce water for flow augmentation to enhance water quality and other beneficial uses conflicts with other water demands. An analytical model is proposed that is capable of allocating water to competing demands on the basis of economic efficiency. The value of water is determined from the slopes of the benefit functions for water uses and an algorithm, based on the theory of marginal analysis, allocates water after considering the complementary and competitive uses of available water. Operations strategies may be selected and revised throughout the demand period regarding the amount of water to remain in storage, or stored and then released for downstream uses or downstream diversions. Results predict the frequency and magnitude of shortages for each beneficial use of water. Simulation of the hydrologic and economic systems of the proposed Holley Reservoir in the Willamette Valley in Oregon was used to test the effectiveness of the proposed analytical model and the results appear very good. A daily streamflow model and a relationship between reservoir operation and recreational attendance were developed to produce an accurate simulation of the basin. Planners, designers, and operations personnel are provided with a method of allocating water in proposed and existing systems. This method indicates the value, extent and magnitude of the complementary and competitive aspects of water storage for water quality control.
W70-04653

MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
Hawaii Univ., Honolulu. Water Resources Research Center.
Daniel H. Hori, Nathan C. Burbank, Jr., Reginald H. F. Young, L. Stephen Lau, and Howard W. Klemmer.
Available from the Clearinghouse as PB-190 271, $3.00 in paper copy, $0.65 in microfiche. Technical Report No 36, Hawaii Water Resources Research Center, January 1970. 40 p. OWRR Project A-001-HI.

Descriptors: *Viruses, Groundwater, Water pollution, Absorption, *Leaching, *Percolation.

A laboratory study was made to determine the ability of three Oahu soils, Wahiawa, Lahaina, (both Low Humic Latosols), and Tantalus cinder to prevent possible contamination of the basal-water lens by the passage of virus. The study was performed utilizing columns containing the selected soils and subject to intermittent percolating water containing a known concentration of Poliovirus Type 2, simulating the action of a cesspool leaching into the ground. The effluent from the soil column was collected and analyzed for viral content by the plaque forming techniques. Breakthrough of the virus occurred in both Wahiawa and Lahaina soils at soil thicknesses of 6-inch, 2 1/2 inch, and 1 1/2 inch at applied concentration of 150,000 pfu/ml of feed solution. The virus removal was over 97 percent of the applied titer. The Tantalus cinder proved ineffective in withholding the virus at the applied concentration of 150,000 pfu/ml of feed solution. The virus breakthrough varies between 39 percent to 78 percent of the applied titer.
W70-04688

UTILITIES ON PERMANENT SNOWFIELDS,
Army Terrestrial Sciences Center, Hanover, N.H.
For primary bibliographic entry see Field 03D.
W70-04740

BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
North Texas State Univ., Denton. Dept. of Biology.
Albert Hendricks, William M. Parsons, Don Francisco, Kenneth Dickson, and Don Henley.
The Texas Journal of Science, Vol 21, No 2, p 175-187, 1969. 3 fig, 4 tab, 18 ref.

Descriptors: *Benthic fauna, Pulp and paper industry, Environmental effects, Texas, Louisiana, Tidal effects, Hydrogen ion concentration, Oxygen, Stratification, Silts, Sands, Muck soils, Organic matter, Forests, Grasses, Swamps, Snakes, Turtles, Cyanophyta, Conductivity, Insects, Crustaceans, Annelids, Mollusks.
Identifiers: *Lower Sabine River (Texas), Salt water wedge, Hexagenia, Caenis, Dromogomphus, Somatochlora, Aphylla, Telebasis, Hetaerina, Tendipes, Chaoborus, Phylocentropus, Mysis, Gammarus, Sphaeroma, Lumbriculus, Branchiuris, Helobdella, Polymesoda, Uniomerus, Notonecta, Pristina, Mytilopsis, Rhantus, Asellus, Laeonereis.

Bottom fauna inhabiting the Lower Sabine River from Morgan Bluff to the Interstate 10 Bridge over the Sabine River, Texas-Louisiana, were the subject of periodical sampling from the summer of 1965 to spring 1968. The purpose was to determine the biological condition of that portion of the river before and during the time that the Owen-Illinois Paper Manufacturing plant was discharging waste. This report enumerates the organisms found at different stations along the river, their habitats and the particular effects of the environment upon them. All organisms reported were collected before any waste from the paper mill had been discharged into the river, except those collected in the spring of 1968. Dissolved oxygen and temperature varied very little among the sampling stations. It appears that during period of low stream flow, the salt water wedge becomes the primary controlling factor over the bottom dwelling organisms in the stream. Type of substrate material appeared to influence to a certain extent the bottom fauna population. It is proposed that periodic high flows of fresh water are instrumental in flushing out the salt water and repopulating portions of the river. (Jones-Wisconsin)
W70-04808

CONTROL OF SULFATE-REDUCING BACTERIA,
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Microbiology Section.
Ronald F. Lewis.
Journal American Water Works Association, Vol 57, No 8, p 1011-1016, 1965. 1 tab, 20 ref.

Descriptors: *Bacteria, *Control, *Sulfates, *Reduction (Chemical), Odor, Pipelines, Corrosion, Rusting, Iron, Oxidation, Linings, Sampling, Aeration, Chlorine, Inhibitors, Hydrogen sulfide, Hydrogen ion concentration, Sewage, Nitrogen compounds, Oxidation-reduction potential, Phenols, Copper compounds, Anaerobic.
Identifiers: Tubercle, Desulfovibrio desulfuricans, Reamer, Chromate ion, Cadmium, Zinc, Formaldehyde, Amines.

Although the importance of sulfate-reducing bacteria in the external corrosion of pipelines is well known, their activity inside water mains is often overlooked. Rusty water or offensive odors at isolated points in a distribution system are often attributable to them. A microbiologic investigation was made of tubercles, water mains and the water, confirming that the organism was the specific sulfate-reducing bacterium, Desulfovibrio desulfuricans. This conclusion is consistent with the problem of rusty water accentuated during the warmer months of the year. A series of investigations was conducted to test media and methods for the detection of sulfate-reducing bacteria. Many types of lining compounds have been evaluated and methods of lowering the corrosivity by mechanical or chemical means. Aeration is useful in preventing sulfate-reducing bacterial growth. Tubercles usually form during periods of low oxygen concentration. Maintenance of residual chlorine throughout a distribution system is one of the best preventive measures against the formation of tubercles, which, limited in drinking water supplies, can help prevent corrosion of sewage mains or control odor. (Jones-Wisconsin)
W70-04813

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER

PROBLEMS).

Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964. 24 p, append.

Descriptors: *Florida, *Legislation, *Water quality, *Water pollution, Standards, Water quality control, Water pollution sources, Administrative agencies, Industrial wastes, Sewage, Sewage treatment, Navigation, Canals, Recreation, Saline water intrusion, Permits, Coasts, Flooding, Flood plains, Drilling, Detergents, Drainage districts, Wells, Water storage.

The Select Committee on Water Resources conducted meetings at various locations around the state in order to familiarize its members with Florida's many water problems. The problems under consideration included: (1) industrial pollution; (2) domestic pollution; (3) deposit of foreign matter in public waters; (4) salt water intrusion; (5) identification and designation of floodplain areas; (6) financing acquisition of water storage lands; (7) licensing of well drillers; (8) hard detergents; and (9) codification of drainage laws. The interest generated at the hearings centered around the general topics of pollution abatement and enforcement and implementation of existing laws. The Committee made various recommendations in each of these areas and proposed legislation to carry out the recommendations. The Committee also suggested that further research be authorized either by a special study group or by an interim committee to report to the next legislature. (See also W70-04882 thru W70-04886). (Dearing-Florida)
W70-04881

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964, p 6-11.

Descriptors: *Florida, *Industrial wastes, *Domestic wastes, *Water pollution sources, Industries, Chemical wastes, Rivers, Bays, Lakes, Streams, Settling basins, Accidents, Water quality control, Economic impact, Recreation demand, Administrative agencies, Legislation, Sewage treatment, Sewage disposal, Septic tanks, Sanitary engineering, Taxes, Local governments, Sewers.
Identifiers: *Accidental pollution.

Legislatively encouraged industrial expansion and development in Florida has created major problems of disposal of industrial wastes, especially chemical wastes. Substantial quantities of wastes have been accidentally and deliberately emptied into the state's streams, lakes, and bays. There has been some effective local pollution control and several instances of voluntary industrial pollution control. The Committee therefore recommends: (1) major changes in responsibilities of administrative agencies to police industry; (2) adequate staffing or existing enforcement agencies; (3) increased encouragement of industry cooperation; (4) concurrent jurisdiction over water quality control for the Board of Conservation and the Board of Health; and (5) repeal of all local legislation that is inconsistent with the proposed state plan. Domestic pollution is a problem similar in magnitude to industrial pollution. Several municipalities still discharge raw sewage into state waters. Future population expansion will require even more sewage treatment facilities than are presently available. The Committee summarized the findings and recommendations of the Board of Health, and further recommended that any discharge of raw sewage into state waters be prohibited and that regular tax returns be withheld from offending local governments. (See W70-04881). (Dearing-Florida)
W70-04882

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).

Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964, p 12-15.

Descriptors: *Florida, *Domestic wastes, *Saline water intrusion, *Legislation, Navigation, Recreation, Navigable waters, Vessels, Water skiing, Coasts, Water pressure, Drainage, Bays, Canals, Rivers, Dams, Tidal waters, Water wells, Rainfall, Water supply, Administrative agencies, Spillways, Permits, Construction, Public health.
Identifiers: *Saline barrier lines.

Navigation and recreational uses of public waters have suffered from deposits of foreign matter in the waters. Sunken vessels and other debris are unsightly and dangerous to sportsmen and recreationists. The Committee recommends that legislation be passed prohibiting such deposit of any foreign matter into public waters. A further problem affecting water supplies in coastal areas is the intrusion of salt water. The primary factors contributing to this intrusion are: (1) loss of fresh water pressure through increased demands of municipalities, agriculture, and industry; (2) excessive drainage; (3) lack of protective works against tidewaters in bays, canals, and rivers; (4) improper location of water wells; and (5) highly variable annual rainfall with insufficient surface storage during droughts. One method of reducing this intrusion requires the establishing of salt barrier lines along coastal areas. No canals or streams could be constructed or enlarged inland from this line unless structures are installed to prevent salt water from moving inland. The Committee recommends that the Board of Conservation be required to establish these lines and that permits be required before any canal can be constructed or any stream enlarged which would discharge into tidal waters. (See W70-04881). (Dearing-Florida)
W70-04883

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).

Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964, p 16-21.

Descriptors: *Florida, *Flood plains, *Water storage, *Legislation, Flooding, Flood protection, Flood forecasting, Flood damage, Flood control, Classification, Administrative agencies, Watersheds, Land use, Government finance, Construction, Water levels, Water supply, Multiple-purpose projects, Construction costs, Project planning, Cost sharing.

There is a need for identification and designation of floodplain areas throughout the state. This would aid prospective land purchasers in selecting property, allow property owners to assess the extent of development that is economically feasible, and aid the landowner in determining the possibility of improvement to prevent or minimize flood damage. The Committee recommends that the Board of Conservation be required to identify and designate such areas which are subject to periodic flooding. The Committee also recommends that adequate funds be secured for the acquisition of water storage lands for several water control projects, especially in the Upper St. Johns River area and the Green Swamp area. Water resources in these areas are being continually diminished and well water levels are being adversely affected. Such water storage areas would help to alleviate this problem and could serve multiple purposes such as recreation and preservation of adequate fresh water supplies. The basic problem in this acquisition of this storage land is the lack of available funds and to this end the Committee recommended several sources for the needed capital. (See W70-04881). (Dearing-Florida)
W70-04884

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964, p 22-24.

Descriptors: *Florida, *Drilling, *Detergents, *Drainage, Legislation, Permits, Wells, Well regulation, Administrative agencies, Subsurface waters, Water conservation, Local governments, Foaming, Water pollution sources, Industrial production, Alkylbenzene sulfonates, Chemicals, Soaps, Drainage districts, Sewerage, Taxes, Compensation, Rivers.
Identifiers: *Esthetic effects, Hard detergents.

Water waste from improper well construction is a basic conservation problem. To help alleviate this situation the Committee recommends that all well drillers in the state be subject to licensing by a state agency and that the Board of Conservation establish statewide drilling standards adaptable to each county's own particular needs and problems. Another water problem arises from the presence of hard detergents (alkyl benzene sulfonate) in state water supplies as evidenced by the presence of foam in rivers, sewage and water treatment plants. While these detergents present no immediate threat to public health, the esthetic effects they produce are of considerable importance to the state. The detergent industries are responding by substituting some soft detergents for the undesirable hard detergents, but legislation is needed to completely ban the sale of hard detergents within the state. The Committee also recommends revision and recodification of the presently inadequate drainage laws. The proposed revision would give drainage districts authority to construct roadways and water and sewage systems. This revision would also remedy present problems of inadequate organization, procedure, compensation, taxing and bonding powers, and excessive tax penalties. (See W70 04881). (Dearing-Florida)
W70-04885

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).

Florida House of Representatives, Tallahassee, Florida, Oct 1, 1964, Appendix.

Descriptors: *Florida, *Legislation, *Water quality, *Water pollution, Water quality control, Standards, Water pollution sources, Administrative agencies, Industrial wastes, Sewage, Sewage treatment, Navigation, Recreation, Saline water intrusion, Permits, Canals, Coasts, Flooding, Flood plains, Drilling, Detergents, Drainage districts, Wells, Water storage.

Based on the foregoing study, the Committee recommends enactment of legislation to: (1) authorize the Conservation Board to establish and enforce water quality standards and to make it unlawful to discharge any pollutants into state waters in violation of the water quality standards; (2) repeal local legislation giving immunity to industrial polluters inconsistent with the proposed water quality control; (3) prohibit the discharge of untreated sewage into state waters; (4) prohibit such discharge of foreign matter into state waters as interferes with navigation and maximum recreational use of public waters; (5) authorize the Conservation Board to establish a state-wide salt water barrier line, and require permits for canal construction or enlargement of natural watercourses in coastal areas; (6) authorize the Conservation Board to identify and designate those areas subject to periodic flooding and considered to be floodplain, swamp, or overflow lands; (7) require the licensing of well drillers, and authorize the Conservation Board to adopt drilling regulations; (8) prohibit the sale, use, manufacture, or possession of hard detergents in Florida; (9) revise drainage district legislation; and (10) appropriate funds for water storage lands especially in the Upper St. Johns River and Green Swamp projects. (See W70-04881) (Dearing-Florida)

W70-04886

OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
Coast Guard, Washington, D.C. Maritime Pollution Control Branch.
Charles W. Koburger, Jr.
Naval War College Review, p 51-58, October 1969. 1 fig.

Descriptors: *Water pollution control, *Waste water treatment, *Oil, *Accidents, *Federal Government, Water utilization, Coast Guard regulations, Boats, Ships, Disasters, Equipment, Planning.
Identifiers: *National Multi-agency Oil and Hazardous Materials Contingency Plan, *On-scene commander, Spill response, Containment, Countermeasures, Cleanup.

Of interest to laymen, students, and professionals alike, this general survey examines the various aspects of the pollution problem in our navigable waters. Examined also are the measures that can be taken to control it, ashore and afloat. It is concluded that, by wisely employing the measures of control we now have and are acquiring, it should be possible to produce a noticeable improvement in our waterways in the near future. Included are two diagrammatic presentations of the various marine pollution disaster control measures and of their relative sequential priority.
W70-04887

CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center.
Richard Havens, and Karl C. Dean.
BuMines Rept. of Inv. 7288, August 1969. 12 p.

Descriptors: *Arizona, *Stabilization, Encrustation, *Sealant, Sulfonates, Polymers, Sprinkling, Uranium.
Identifiers: *Erosion control, Slope stabilization, Air pollution, Arid land, *Tuba City.

Acidic and basic uranium leach plant residues located on the Navajo Indian Reservation, Tuba City, Ariz., were successfully stabilized against wind erosion using a relatively low-cost chemical method. An elastomeric polymer chemical was applied to the dike areas and a calcium magnesium lignosulfonate to the beach areas of three tailings ponds. The water-soluble chemicals were applied with an automated sprinkling system. The stabilization cost was $335 per acre for the 34.5-acre tract.
W70-04888

06. WATER RESOURCES PLANNING

6A. Techniques of Planning

AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
Stanford Univ., Calif. Dept. of Civil Engineering.
Ray K. Linsley, Stephen J. Burges, and Peter W. Whitford.
Available from the Clearinghouse as PB-190 194, $3.00 in paper copy, $0.65 in microfiche. Stanford, California, Department of Civil Engineering, Technical Report No. 122, Dec. 1969. 76p, 31 fig, 3 tab, 37 ref. OWRR 14-01-0001-1968, OWRR Project C-1321 (1968).

Descriptors: *Decision making, *Planning, Hydrology, Methodology, Reservoir design, Risks, Water utilization, Water supply, Flood control.

Results are presented of exploratory attempts to construct the flow of decisions and data into the design of single purpose water supply and flood control projects. Estimates of uncertainty in each of the data inputs and in each calculation in the analysis were made and a distribution of error in the final project cost or benefit-cost ratio determined. Because of scarcity of data on the magnitude of individual uncertainties most values were estimated on the basis of judgment. The results suggest the possibility of a substantial uncertainty in the ultimate values and indicated that a more thorough investigation of individual components of uncertainty was warrented. The report contains a fairly extensive analysis of the probability characteristics of damage estimates in flood control planning based on the work of James, Benson, and Homan and Waybur. The problem of forecasting water demand for urban requirements is reviewed and some of the problems involved in making these forecasts are discussed. A study was made of hydrologic procedures and their influence on the uncertainty in estimating a required reservoir capacity. The report examines stochastic methods and results obtained suggest that for arid regions very long records of observed streamflow are necessary to properly identify statistical parameters and very long stochastic simulation periods are needed to define a stable distribution of storage requirements.
W70-04544

MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 04C.
W70-04575

BIG BLUE RIVER BASIN.
Nebraska Soil and Water Conservation Commission, Lincoln.
For primary bibliographic entry see Field 02E.
W70-04603

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 04C.
W70-04723

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKE-WATER CREEK, TEXAS,
Texas Univ., Austin, and Texas Tech Univ., Lubbock.
For primary bibliographic entry see Field 04C.
W70-04726

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 02A.
W70-04729

QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
Institut fuer Wasserwirtschaft, Berlin (East Germany).
For primary bibliographic entry see Field 04A.
W70-04748

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
Toronto Univ., (Ontario). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 04A.
W70-04749

SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, AND E. G. Roberts.
Cambridge, Massachusetts, The M.I.T. Press, 1969, 275 p, 57 fig, 52 tab, 1 chart, 158 ref, 4 append.

Descriptors: *Simulation analysis, *Methodology, Computer models, Regional analysis, Computer models, Mathematical models, Management, Decision making, Dynamic programming, Human population, Economic life, Water demand, Water quality, Water supply.
Identifiers: *Susquehanna River Basin, Social sciences, Regional goals, National goals, State of the art, Demographic variables, Employment variables, Water variables.

The book has thirteen chapters. Chapter I introduces the book. Chapter II discusses the problems surrounding model-building research in the social sciences in general and in economics in particular. Chapter III reviews the state of the art in regional economic analysis. Chapter IV compares the Susquehanna model to other regional-economic and river-basin models. Chapter V discusses the philosophy and methodology of approach of the Susquehanna model. Chapter VI describes the methodology for devising economic sub-regions within the basin, and discusses economic and population variables among the sub-regions. Chapter VII gives a brief overview of the model. Chapters VIII-XI discusses individual sectors of the model, the demographic sector, the employment sector, and the water sector. The employment sector takes two chapters: Chapter IX presents the basis for sectoring the employment structure and for identifying endogenous and exogenous forces shaping the regional economy; Chapter X concentrates on export industries. Chapter XII describes several model simulations and suggests model refinements. Chapter XIII summarizes some of the lessons learned during the research. The chapter emphasizes the value of a 'balanced and iterative' research strategy. (See also W70-04836 thru W70-04845). (Gossen-Chicago)
W70-04835

CHAPTER I: INTRODUCTION AND SUMMARY,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, pp 1-15, 1 fig.

Descriptors: *Simulation analysis, *Methodology, Economics, Computer models, Regional analysis.
Identifiers: *Susquehanna River Basin.

Chapter I is divided into four sections. Section I describes the research problem and how it was approached. The initial problem was to analyze the economy of the Susquehanna River Basin, to define the role of water resources in this economy, and to develop improved techniques for accomplishing this type of analysis. The research program was carried out in three major steps: (1) problem definition and technique selection; (2) model development; and (3) model refinement. The section describes the effectiveness of computer application. It should be used to generate different sets of projections under alternative assumptions regarding data and functional relationships. Section II describes peculiarities of the Susquehanna River Basin economy and of the Susquehanna model. Section III outlines the book. Section IV emphasizes that the Susquehanna model is not a 'general' regional model. Each separate region has a specific set of demands, and so requires an individual model. However, the Susquehanna model represents a significant advancement in the state of the art by typing together the employment, demographic, and water sectors of a large region in one model. (See W70-04835). (Gossen-Chicago)
W70-04836

CHAPTER II: PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, pp 16-33, 42 ref.

Descriptors: *Mathematical models, *Economics, Methodology, History.
Identifiers: *Social sciences, Tinbergen, Haavlemo, Cowles Commission, Research.

The purpose of Chapter II is to explicate issues surrounding the role of mathematical models in the social sciences. Section I focuses on social sciences in general. It maintains that the use of mathematical models is a key element in the scientific method, both in the natural sciences and in the social sciences. Issues regarding the appropriateness of mathematical models to the social sciences are discussed. Section II focuses on economics. It outlines a history of the use of mathematical models in economics. Empirically implemented mathematical economic models were a twentieth-century development. The work of Tinbergen, Haavlemo, and the Cowles Commission is described, and criticisms to their work are discussed. Subsequent efforts to resolve these problems are discussed. Results of these efforts include: (1) tremendous growth in the volume and quality of empirical work; (2) a new set of techniques for estimating parameters of models; (3) significant contributions toward the use of models for policy purposes; (4) work on checking the accuracy of forecasts yielded by economic models; and (5) progress in the study of the dynamic properties of economic models. Model building is an important subject that has received little attention. (See W70-04835). (Gossen-Chicago)
W70-04837

CHAPTER III: REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts, The M.I.T. Press, 1969, pp 34-53, 13 ref.

Descriptors: *Economics, *Regional analysis, Income analysis, Computer models, Institutional constraints, Water law, Third party effects, Management, Decision making.
Identifiers: *River basin planning, Regional goals, National goals, Market economy.

Chapter III purposes to show the interrelationships between regional economic analysis and river basin planning. Section I describes the nature of regional analysis. Section II describes the difficulties of regional analysis, most of which arise because theories of regional income generation are insufficiently developed. Difficulties include: defining regions; collecting data; and identifying income generated within a region. Section III discussed three problems of specifying goals for regional planning: (1) many conflicting regional goals may exist; (2) various groups may not agree on the ranking of goals; and (3) regional goals may not reflect optimal development for the nation. Particular goals are related to particular economic models for projecting future economic activity. Section IV addresses problems of relating regional development to the existing institutional framework, and Section V discusses the design of more efficient institutions. The current poor management of water resources has two causes: (1) existing water laws disregard obvious externalities; and (2) the operation of water law prevents development of a market system which might facilitate transfer of water to new uses in response to changing economic relationships. Different regions will require different institutional combinations of centralized decision making and use of the market. (See W70-04835). (Gossen-Chicago)
W70-04838

CHAPTER IV: CONTEMPORARY REGIONAL PROJECTION MODELS,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. G. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p 54-87, 36 ref.

Descriptors: *Computer models, Economic prediction.
Identifiers: State of the art, New York Metropolitan Region Study, Upper Midwest Economic Study, Ohio River Basin Study, California Development model, Oahu model, Lehigh Basin model, Susquehanna River Basin Studies.

After briefly discussing the general nature of regional economic projections, the chapter discusses six regional models to illustrate the current state of the art. The models discussed are: (1) the New York Metropolitan Region Study; (2) the Upper Midwest Economic Study; (3) the Ohio River Basin Study; (4) the California Development model; (5) the Oahu, Hawaii model; and (6) the Lehigh Basin simulation model. The National Planning Association's study of the Susquehanna River Basin is briefly discussed. These models offer a perspective for discussion of the Battelle Memorial Institute's Susquehanna model in subsequent chapters. There are four major differences between the Susquehanna model and the other models discussed. The Susquehanna model: (1) combines the demographic and economic sectors in one model; (2) is of a simulation type that makes it possible to insert a wide variety of assumptions and parameters and to employ sensitivity analysis; (3) is of a dynamic type, which allows explicit feedbacks and lagged variables within and between sectors; and (4) is the only model to combine the economic and water sectors. (See W70-04835). (Gossen-Chicago)
W70-04839

CHAPTER V: PHILOSOPHY AND METHODOLOGY OF APPROACH,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p 88-114, 9 fig, 1 tab, 1 chart, 17 ref.

Descriptors: *Methodology, Regional analysis, Dynamic programming, Simulation analysis, Model studies.
Identifiers: Susquehanna River Basin, Feedback relationships, Continuous simulation, DYNAMO.

Chapter V describes how the general considerations of regional economic analysis and the particular objectives of the Susquehanna study led to the selection of the particular mathematical approach. Problem characteristics arising in regional analysis usually demand methodologies that: (1) contain the capacity to treat a large number of variables; (2) have the flexibility for handling wide variations in data types and functional relationships; (3) are oriented toward dynamic considerations including consideration of time-varying factors; and (4) permit inclusion of feedback relationships. Nonquantitative and quantitative methods of regional analysis are discussed. Simulation methods offer significant advantages: (1) simulation can be inexpensive; (2) minor changes can be easily made; (3) the model is not restricted to linear formations; and (4) the model can contain many variables. Of the three types of simulation, continuous simulation was chosen for the Susquehanna problem, because costs were reasonable, numerical methods for approximating simultaneous differential equations were developed, and a computer program, called DYNAMO, was available. The specific methodology has four steps: (1) problem definition; (2) model construction; (3) model simulation; and (4) model validation. Each step is fully described. Discussion is illustrated by the step-by-step development of a simply, hypothetical regional model. (See W70-04835). (Gossen-Chicago)
W70-04840

CHAPTER VI: THE REGIONAL SETTING OF THE STUDY,
Battelle Memorial Inst., Columbus, Ohio, Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p 115-124, 1 fig, 6 tab, 2 ref.

Descriptors: *Methodology, Regional analysis, Human population, Economic life, Water demand.
Identifiers: *Susquehanna drainage basin, Economic autonomy, Economic development.

Chapter VI describes the Susquehanna River and the economy of its drainage basin. The study area was delimited by the hydrologic entity, regional economic considerations, and data considerations. Because of these factors, the study area selected was composed of whole county units. Division of the area into subregions was necessary for two reasons: (1) the various economies within the study area were developing at grossly different rates; (2) subregionalization was the first step in localizing water needs. Subregions were drawn within the context of defined labor markets and retail and wholesale trading areas. Subregions were selected that minimized commuting from one subregion to another, in order to define subregions with minimum of economic interdependence. There are eight subregions: Elmira; Binghamton; Williamsport; Sunbury; Wilkes-Barre-Scranton; Altoona; Harrisburg; and Baltimore. Each of these includes several counties. The final section of the chapter compares economic and population variables of the subregions. (See W70-04835). (Gossen-Chicago)
W70-04841

CHAPTER VII: AN OVERVIEW OF THE MODEL,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p. 125-132, 5 fig.

Descriptors: *Methodology, *Computer models, Human population, Labor supply, Unemployment, Migration patterns, Water quality, Water supply, Regional analysis.
Identifiers: Susquehanna drainage basin, Demographic variables, Employment variables, Water variables, Feedback effects, Low-flow measurement, Model output.

Chapter VII summarizes the model's major sectors. The Susquehanna model contains models of each of the economic subregions. These subregional models are composed of three major sectors: demographic and employment sectors are related by a feedback loop including population, laborforce, unemployment and migration variables. Section I discusses the demographic sector. Three factors--births, deaths, and migration--are involved directly in population change, migration being the most dynamic. In this model, migration ties together the demographic and employment sectors. Section II discusses the employment sector. There

are three employment categories: export industries; wholesalers; and retailers. The driving force of the model is Market Area Demand operating through export industry employment. Section III discusses the water sector. Specific locations with existing or possible water problems were analyzed for quality and quantity with a simple, hydrological low-flow model. The water sector ties together all the subregions, with regard to changes in water quantity and quality. It also tests the potential effects of constructing dams and reservoirs. Section IV briefly discusses model output. General principles for plotting variables are given. (See W70-04835). (Gosseen-Chicago)
W70-04842

CHAPTER XI: THE WATER SECTOR,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p 206-233, 8 fig, 4 tab, 19 ref.

Descriptors: *Methodology, *Computer models, Water quality, Water supply, Regional analysis, Simulation analysis, Flood control, Acid mine water, Hydroelectric power, Navigation, Irrigation, Water works, Dissolved oxygen, Recreation, Economic impact, Forest management.
Identifiers: *Susquehanna drainage basin.

The water sector is viewed as a 'technical sector' that is appended to a more general regional simulation model. This sector could be replaced or augmented by other technical factors peculiar to another region. Section I, focusing on methodology, discusses: the separation of the water problem into quality and quantity considerations; the choice of problem areas for analysis; the mechanics of river simulation; and water variables excluded from the model. Water variables excluded are flood control, acid mine drainage, hydropower production, navigation, and irrigation, each of which are discussed. Section II focuses on general water quality and quantity considerations. Use of the water sector allows assessment of important aspects of works construction in relation to dissolved oxygen levels, water quantity, the economic impact of recreation, and the economic impact of the construction of the works themselves. Impact of water on economic development is negligible. Only locations with possible water problems are considered in the model. This approach is practical to study a given basin; it is not intended to provide a general model. Section III discussed forest management to illustrate the dynamics of other kinds of technical sectors. (See W70-04835). (Davis-Chicago)
W70-04843

CHAPTER XIII: IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p. 258-275, 1 fig, 7 ref.

Descriptors: *Methodology, Feasibility studies, Model studies, Simulation analysis, Data collections, Statistical models, Mathematics, Dynamic programming, Mathematical models, Data processing, Regional analysis, Computer models.
Identifiers: *Research needs, Susquehanna model, Objectives, Multidisciplinary approach, Iterative research strategy, Alternative methodologies, Operational models, Disaggregation, Public use, Private use.

Section I presents principles which emerged from the Susquehanna regional model-building effort. Planning a model requires clearly stated objectives, a multidisciplinary approach, and an iterative research strategy, which is described extensively. After agreeing on objectives, researchers should undertake an exploratory study to determine the feasibility of the research effort, compare alternative methodologies, and explicate the nature and availability of needed inputs. The second phase involves construction of an initial model. Phase three involves repeated computer simulation testing and reformulating of the initial model. A comparison with other model-building approaches shows that few efforts have employed an interative research strategy. Many models have been built without computer simulation experiments, with too much dependence on one set of data, or with an overemphasis on statistical criteria. Section II summarizes salient features of the Susquehanna model and suggests areas for additional research. The model: (1) is a mathematical model; (2) is an operational model; (3) is data based; (4) provides great detail by disaggregation; (5) incorporates significant advances in formulating the demographic sector; (6) generates outputs relating to water quantity and quality for various points on the river; and (7) illustrates how the computer has affected social scientific research. Section III describes future uses of regional simulation models, including public policy uses and private uses. (See W70-04835). (Gossen-Chicago)
W70-04844

APPENDIX A: THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
H. R. Hamilton, S. E. Goldstone, J. W. Milliman, A. L. Pugh, III, and E. B. Roberts.
In: Systems Simulation for Regional Analysis. Cambridge, Massachusetts: The M.I.T. Press, 1969, p. 276-288, 1 fig, 1 ref.

Descriptors: *Personnel management, *Methodology, Project planning, Professional personnel, Scientific personnel, Psychological aspects, Simulation analysis, Model studies.
Identifiers: Multidisciplinary studies, Small projects, Accounting system.

This appendix emphasizes that management is necessary to integrate even highly competent individuals into an effective research team. The management role in multidisciplinary studies is often ignored because small project coordinators usually have less interest in project management per se than in emphasizing their research specialties. In small studies, problems of the project coordinator most often involve personal characteristics of team members. Some must be urged to communicate with other project staff; others must be restrained from overcommunicating. In modeling studies, the major goal should be to study the problem by constructing a balanced model. To do so, the manager must be flexible enough to reassign people among tasks and to alter the research team. A good accounting system is about the only management aid a small-project manager has. He can devise other aids on an ad hoc basis. Because so much research is carried out by small groups, more attention should be given to management of such studies and to providing directors of this research with better tools for achieving high research efficiency. (See W70-04835). (Gossen-Chicago)
W70-04845

WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
Battelle Memorial Inst., Columbus, Ohio.
Neil L. Drobny.
American Water Resources Association, Proceedings of the Fourth American Water Resources Conference, November 18-22, 1968. p 534-555, 3 fig, 1 tab, 45 ref.

Descriptors: *Systems analysis, *Methodology, *Decision making, *Mathematical models, Linear programming, Dynamic programming, Stochastic processes, Queueing theory, Simulation analysis, Model studies, Markov processes, Statistical models.
Identifiers: *Policy, Nonlinear programming, Statistical decision theory, Inventory theory.

In the context of this paper, systems analysis refers to a strategy for problem solving which relies heavily on mathematical modeling to assess the technical and economic optimality of alternative system designs, policies and operating procedures for performing various functions and meeting various needs with limited resources. It is important to keep in mind that systems analysis per se does not provide these assessments which also must incorporate professional, legal, political and social considerations. Rather, systems analysis may be employed as a decision aid in assessing the technical and economic consequences of alternative courses of action. Systems analysis techniques have several advantages over traditional methods of design and analysis: (1) systems analysis techniques provide for a more effective union of engineering and economic considerations into the problem formulation and solution procedure; and (2) systems analysis also provides a means for incorporating considerations relating to risk and uncertainty. The following techniques are discussed: (1) optimization programming models; linear programming, nonlinear programming and dynamic programming; (2) stochastic models; statistical decision theory, queueing theory, inventory theory, and markov processes; and (3) simulation models. Limitations on the application of systems analysis to problems in water resources are discussed and viewed as being of two types--data limitations and conceptual limitations. (Davis-Chicago)
W70-04900

WATER SYSTEMS MODELING,
Illinois Univ., Urbana.
Dale D. Meredith.
In: Appendix C of 'Analysis of Water and Water-Related Research Requirements in the Great Lakes Region' Council on Economic Growth, Technology, and Public Policy of the Committee on Institutional Cooperation, June 1968. 17 p, 30 ref, p 61-77.

Descriptors: *Mathematical models, *Model studies, *Great Lakes, Methodology, Great Lakes region, Hydrologic model, Simulation, Systems analysis.

This article maintains that a systems model of the Great Lakes area can be developed. After a thorough review of contemporary attempts at model development, for both systems and subsystems; two basic approaches to a complete system model are discussed, a complete computer simulation and a gaming-situation. The following method in developing a Great Lakes System model is outlined: (1) define questions to be answered by the model, (2) make a 'rough cut' of the model and determine the relevant subsystems to be included, (3) examine the subsystems to determine the areas of the model which are well defined and those which are least well defined, (4) give highest priority for research to those areas of greatest weakness in the model, and (5) maintain a series of working conferences which meet periodically to keep the focus on the overall model and its development. This step is important in that it enables the researchers in the various disciplines to see where their work fits into the model and also to see the kinds of results they need to make their work compatible with the information needed by the model. This model could be modular, so that different sectors could proceed at different rates of development, the critical factor being that the various models must eventually be compatible. The above procedure could be used for either a model of the entire Great Lakes area or for a subregion. (Davis-Chicago)
W70-04901

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
North Carolina Univ., Chapel Hill.
Jabbar K. Sherwani.
Multidisciplinary Research As An Aid To Public Policy Formation, Virginia Polytechnic Institute, Blacksbury, p 1-19, December 8 1965. 19 p, 3 ref.

Descriptors: *Optimization, *Water utilization, *Mathematical models, *Simulation analysis, *Input-output analysis, Public benefits, Decision making, Investment, Regional analysis.
Identifiers: Public policy.

Optimum water use in a regional setting was discussed and a multidisciplinary water utilization plan was presented. The plan was based on an optimizing approach to public policy making. Water policy problems were split into two groups: those relating to public investment in water projects and those regulating the decision making process of self-supplied water firms. Optimum water use could not be determined in isolation. Cooperative research between engineers and economists was needed to establish the structural parameters involved in alternative uses which governed the direction of water use. Mathematical models for determining the optimum use of water were recommended. Input-output models, programming techniques, and simulation models were discussed and recommended. It was contended, however, that quantitative models were only indicative of the optimum direction for public policy: necessary but not sufficient. The implementation of these models is in the sphere of the political process. (Thiuri-Cornell)
W70-04986

MARKOV MODELS FOR FLOW REGULATION,
Cornell Univ., Ithaca, N.Y. School of Civil Engineering.
Moshe Gablinger, and Daniel P. Loucks.
Journal of the Hydraulics Division, Proceedings of ASCE, Vol 96, No HY1, p 165-181, January 1970. 17 p, 1 fig, 5 tab, 14 ref, 2 append.

Descriptors: *Markov processes, *Linear programming, *Dynamic programming, *Flow measurement, *Flow control, Reservoirs, Numerical analysis, Efficiencies, Economics, Multiple-purpose reservoirs, Models.
Identifiers: Alternative policies.

The problem of defining alternative operative policies for a single multipurpose reservoir was examined through the use of several pairs of discrete stochastic linear and dynamic programming models. The net flows into the reservoir were assumed to be serially correlated, their probabilistic sequence defined by first order Markov chains. Each linear programming model was shown to correspond to a dynamic programming model. The solutions and computational efficiencies of each of the models were compared using a simplified numerical example based on an actual reservoir operating problem. Although the policies obtained from each pair of corresponding models were identical, the time required to solve the dynamic programming models was less than that required for the linear programming models. However, for reservoir problems that were not too large, it was indicated that it might be more economical to use linear programming. (Thiuri-Cornell)
W70-04987

INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
Harvard Univ., Cambridge, Mass. Harvard Development Advisory Service.
Henry D. Jacoby.
Regional Science Association Papers, Vol 21, p 125-137, November 1967. 13 p, 1 fig, 10 ref.

Descriptors: *Water resources, *Power system operations, *Simulation analysis, *Hydroelectric power, *Decision making, Planning, Investment, Marketing, Computers.
Identifiers: Power interconnections, Models.

A mathematical model was developed and applied to an interconnection of independent regional power utilities. A simulation model was developed to assist in making decisions on investment selections, operating policies, and pricing arrangements. Interconnections between three major cities in Colombia - Bogota, Medellin and Cali - were chosen to illustrate the use of the model. The planning method presented involved the use of digital computer simulation as a tool for analyzing potential investment in generation facilities in each of several electric power markets, for evaluating connections among markets, and for studying alternative schemes for operating such interdependent systems. The model made it possible to analyze a large number of alternative investment schemes and operating policies with relative ease and in a small amount of time. (Thiuri-Cornell)
W70-04988

PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
Wisconsin Univ., Madison. Dept. of Civil Engineering.
Paul M. Berthouex.
Journal, Amer Water Works Association, Vol 61, No 12, p 652-658, December 1969. 7 p, 6 fig, 4 tab, 9 ref.

Descriptors: *Probability, *Risks, *Decision making, *Pilot plants, *Design, Technical feasibility, Filtration, Networks, Cost analysis, Economics, Oxidation, Iron.

Probability theory was used to solve a complex network problem and to evaluate various pilot water treatment plant alternatives under uncertainty. The purpose of the pilot water treatment plant study was to reduce technical and economic risks in design, and to provide data useful for scaling up to plants of commercial size. A treatment plant using iron removed by oxidation and rapid sand filtration was used as an example. Network cost analysis was recommended for situations when the probability of getting an acceptable process was low. The probability distribution of obtaining an acceptable outcome was shown for the pilot project example. (Thiuri-Cornell)
W70-04989

DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
Norwegian Water Resources and Electricity Board, Oslo.
Vidkunn Hveding.
Economics of Planning, Vol 8, No 1-2, p 118-139, 1968. 22 p, 10 fig.

Descriptors: *Simulation analysis, *Hydroelectric power, *Planning, *Power system operation, *Demand, Storage capacity, Benefits, Efficiencies, Computers, Irrigation, Thermal power, Reservoirs, River systems, Model studies.
Identifiers: Huita-Thjoysa River.

Single plant and multiple plant simulation models were developed for the purpose of planning water reservoirs to provide hydroelectric power. The operational objective was to divide total load at any given moment among the existing units so as to maximize overall efficiency. The planning objective was to provide, in addition to sufficient plant capacity, storage facilities that would maximize total benefits from the system. A demand function for power was developed and various expansion alternatives to meet this demand by a single plant or by multiple plants were compared. The effect of adding a thermal power plant to the hydropower system was applied to the Huita-Thjoysa river system in the operation of the model. It was suggested that the model could also be applied to irrigation allocation problems. (Thiuri-Cornell)
W70-04991

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
Battelle Memorial Inst., Columbus, Ohio.
For primary bibliographic entry see Field 04A.
W70-04992

PROBABILISTIC RESERVOIR DESIGN,
Lancaster Univ., Bailrigg (England). Dept. of Mathematics.
For primary bibliographic entry see Field 04A.
W70-05031

6B. Evaluation Process

AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
Stanford Univ., Calif. Dept. of Civil Engineering.
For primary bibliographic entry see Field 06A.
W70-04544

REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
California State Dept. of Water Resources, Los Angeles.
For primary bibliographic entry see Field 04B.
W70-04604

ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
Resources for the Future, Inc., Washington, D.C.
For primary bibliographic entry see Field 04B.
W70-04614

IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
Texas Tech Univ., Lubbock.
For primary bibliographic entry see Field 03F.
W70-04618

FRESH WATER SUPPLIES THROUGH DESALINATION,
Department of the Interior, Washington, D.C.
For primary bibliographic entry see Field 03A.
W70-04647

THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
California Univ., Riverside. Dept. of Economics.
For primary bibliographic entry see Field 05D.
W70-04648

ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
Louisiana Water Resources Research Inst., Baton Rouge.
For primary bibliographic entry see Field 04B.
W70-04650

COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (An Engineering-Economic Approach to Evaluate the Extent and Magnitude of the Complementary and Competitive Aspects of Water Storage for Water Quality Control),
Sacramento State Coll., Calif. Dept. of Civil Engineering.
For primary bibliographic entry see Field 05G.
W70-04653

WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.
Jacquelyn L. Beyer.
Available from the Clearinghouse as PB-190 273, $3.00 in paper copy, $0.65 in microfiche. New Jersey Water Resources Research Institute, Progress Report, Rutgers University, December 1969. 20 p, 2 tab, 1 fig. OWRR Project A-024-NJ.

Descriptors: *Water quality, *Environment, *Environmental effects, Behavior, Social aspects, Economics.
Identifiers: *Residential location desirous, Homesites, Water-based homesites.

The objective of the research was to investigate the probability of finding enough information to warrant an intensive study of the economic effects of water quality upon residential location decisions. The investigation was localized to the Rockaway River area, where water pollution problems are known to have been serious, and considerable local interest in the matter was known to exist. It seems on the basis of this exploratory study that water quality has a relationship to value of homes in the Rockaway River area. Homeowners along clean sections of the river consider its presence an advantage; whereas along polluted sections, homeowners consider the river detrimental. However, there are so many complicating factors that the results obtained are statistically indeterminate. More intensive analysis would be required to separate out the effects of pollution from effects of flood risks, differing economic status of sample populations, extent of knowledge or ignorance of the situation and the constraint imposed by the legal imposition of a freeze upon construction, which tended to raise values of existing homes through scarcity. Guidelines for further research are suggested.
W70-04686

RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
California Univ., Berkeley. Center for Research in Management Science.
For primary bibliographic entry see Field 06F.
W70-04689

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
Texas Water Development Board, Austin; and International Boundary and Water Commission, El Paso, Texas.
For primary bibliographic entry see Field 04C.
W70-04724

RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
William C. Ackermann, Norman H. Crawford, Carl F. Izzard, Max Kohler, and Walter B. Langbein.
Office of Water Resources Research, Report of Panel on Watershed Research, June 1966. 21 p, 21 ref.

Descriptors: *Water resources research act, *Research and development, *Research facilities, Demonstration watersheds, Model studies, Hydraulic models, Mathematical models, Urbanization, Grants, Laboratories, Planning.
Identifiers: Water resources research.

An advisory report on watershed research is presented, covering the following subject areas: (a) The principal subject-matter and geographic areas of watershed research for which previous work has already provided substantially adequate knowledge; (b) watershed research subjects or techniques which past work indicates are not likely now to yield results sufficient to justify additional substantial research effort; (c) watershed research subjects that now appear promising areas for increased emphasis; and (d) recommendations as to measures under the Water Resources Research Act that might aid in bringing about needed increases of research. The panel recommendations for consideration of OWRR in administering programs under P.L. 88-379 cover watershed research on: experimental watersheds, representative watersheds, physical models, mathematical models, and effects of urbanization. Mathematical modeling of watershed behavior is a fruitful field of study. Greater emphasis on the subject of effects of urbanization is recommended. (Knapp-USGS)
W70-04760

THE DELAWARE RIVER BASIN COMMISSION, A PROTOTYPE IN RIVER BASIN DEVELOPMENT,
Delaware River Basin Commission, Washington, D.C.
Vernon D. Northrop.
Journal of Soil and Water Conservation, Vol. 22, No. 2, Reprint, March-April 1967, 4p., 2 photo, 1 ref.

Descriptors: *Interstate commissions, Water supply, Water pollution.
Identifiers: *Delaware River Basin Commission, Clean Water Restoration Act.

The water crisis of the last third of the 20th century includes a tripling of water supply needs by the year 2000, an inadequate water supply, and the need of between $40 billion to $100 billion to win the fight against water pollution. The article discusses the development of a federal-interstate compact organization as a mechanism for dealing more effectively with the water problems. The characteristics and importance of the Delaware River are presented along with a discussion of two previous compact plans. Four states, New York, Pennsylvania, New Jersey and Delaware, organized the Delaware River Basin Advisory Committee. This Committee developed a federal-interstate compact, developed the type of organizational approach for the Delaware basin, and drafted the terms of the compact and obtained support for its enactment. The resulting federal-interstate agency has proven to be an effective organization; it is responsible for the Clean Water Restoration Act. Fears of conflicts of interest have been unfounded. (Grossman-Rutgers)
W70-04824

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT: A PANEL DISCUSSION,
Soil Conservation Service, Washington, D.C.
Charles F. Lemon.
Conf. Proc., Comm. on the Econ. of Water Resources Develop., Denver, Colo., p. 91-97, Dec. 17-18, 1968. 7p., 1 tab.

Descriptors: *Discount rate, *Small watersheds, Federal government, Interstate.
Identifiers: Water Resources Council.

The implications of various discount rates on water resource projects under the small watershed program, as administered by the Soil Conservation Service, are described. First a historical background of the small watershed program is presented. Then the discount rate as proposed by the Water Resources Council is presented. This discount rate is based on the interest rate on the average yield during the preceding fiscal year on the interest-bearing marketable securities of the United States. This formula leads to a higher rate. Its effect is demonstrated by an analysis of the watershed project in the Ozark region of Arkansas. A table is presented which indicates the effect of using the higher interest rate of 4 5/8 percent for benefit-cost evaluation. (Grossman-Rutgers)
W70-04825

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT: A PANEL DISCUSSION,
Water Resources Council, Washington, D.C.
Harry A. Steele.
Conf. Proc., Comm. on the Econ. of Water Resources Develop., Denver, Colo., 83-85, Dec. 17-18, 1968. 3p, 1 graph.

Descriptors: *Discount rate, Interest rate, Water Resources Planning Act, Economic efficiency, Federal government.
Identifiers: Coupon rate, Government bonds, Water Resources Council.

The difference between discount rates based on the opportunity costs in private market and that based on social time preference is so great that the method chosen will drastically change the formulation of water resources plans. Therefore, the choice of the discount rate will affect many policy objectives and economic efficiency. Under the Senate Document 97 the yield rate on long-term government bonds (i.e., coupon rate) was used as the discount rate. In July of 1968, the Water Resources Council proposed a formula which would start at 4 5/8 percent and change with the average yield on long-term bonds of the preceding year but not more than one percentage point in any one year. A later proposal would be a discount rate starting at 4 5/8 percent and would use a 5-year moving average, but limiting yearly changes to 1/4 of a percentage point. A task force and natural and regional hearings are intended to improve procedures in determining the discount rate and planning policies. A graph illustrating the second discount rate proposal overtime is given. (Grossman-Rutgers)
W70-04826

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION-VIEWS FROM THE FEDERAL GOVERNMENT: A PANEL DISCUSSION,
Office of the Chief of Engineers (Army), Washington, D.C. Civil Works Directorate.
B. J. Tofani.
Conf. Proc., Comm. on the Econ. of Water Resources Develop., Denver, Colo., pp. 99-101, Dec. 17-18, 1968. 3 p.

Descriptors: *Discount rate, *Resource development, Federal Government.
Identifiers: Water Resources Council, Corps of Engineers.

The effect of a higher discount rate is found within the scope of individual projects. Under the higher rate the increments of projects will be found unjustified, therefore projects will end up smaller. Also, other projects will be restricted due to the higher rate. The magnitude of construction under the Corps of Engineers' program is not directly affected by the discount rate for the primary constraint of the program is the funding level. Under the higher discount rate in project evaluation, lesser weight is given to future benefits in comparison to near-term benefits. A brief history of the role of the Federal Government in water resources is presented. Its role in water resources development is found to be a complicated one. (Grossman-Rutgers)
W70-04827

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT: A PANEL DISCUSSION,
Committee on Appropriations (U.S. Senate).
Kenneth J. Bousquet.
Conf. Proc., Comm. on the Econ. of Water Resources Develop., Denver, Colo., pp 103-106, Dec. 17-18, 1968. 4p.

Descriptors: *Discount rate, Resources development, Cost-benefit analysis.
Identifiers: *Senate Subcommittee on Economy in Government, Water Resources Council.

The increase in the discount rate from 3 1/4 percent as set forth in Senate Document 97 to 4 5/8 percent as proposed by the Water Resources Council is a 42 percent increase. It is suggested that a stepped increase occur to allow time for the development of better techniques of project benefits. In the field of water resources development benefit-to-cost analyses are made to determine if the objective of the project is to be met. An example of the type of analysis that follows from recommendations of the Senate Subcommittee on Economy in Government as applied to a business is presented. The example cited shows that a higher discount rate decreases the apparent desirability of

projects where the benefits increase over the life of the project than those where the early returns are high. A high proportion of early returns usually means a less than optimum size project. (Grossman-Rutgers)
W70-04828

THE VALUE OF RESERVOIR RECREATION,
Cornell Univ., Ithaca, N.Y. Dept. of Agricultural Economics.
Jeff Romm.
Cornell University Water Resources and Marine Sciences Center, Technical Report No. 19, Aug. 1969, 102p, 19 fig, 24 tab, 15 ref.

Descriptors: *Recreation, *Reservoirs, *Public benefits, Cost-benefit analysis, Recreation demand, Estimating.
Identifiers: *Whitney Point Reservoir, *Recreation benefit estimating.

This study compares several techniques of estimating and benefits of reservoir recreation. A survey was taken at Whitney Point Reservoir, Broome County, New York; the results were used as sources of data for this study. The survey methodology is discussed, and the purposes of recreation benefit estimating and demand estimation techniques are examined. Then the following techniques are explained and examined: The Clawson Approach, Consumer Surplus Approach, Willingness to Pay, Government Payment, Consumers Preference Approach, Social Preference, and Requirements Approach. The results for the different estimation techniques are summarized. Finally, public needs and administrative goals are examined and a conclusion is included. (Grossman-Rutgers)
W70-04829

ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
Water Resources Council, Washington, D.C.

Washington, D.C.: Water Resources Council, August 1967, 8 p.

Descriptors: *Management, *Administration, *Planning, *Institutions, *River basins, Institutional constraints, Interstate compacts, Interstate commissions, River basin commissions.
Identifiers: *River basin management.

The report reviews eight types of management arrangements: (1) the interstate compact; (2) the federal interstate compact; (3) river basin commissions; (4) basin inter-agency committees; (5) regional federal-state commissions; (6) intra-state special districts; (7) the federal regional agency; and (8) the single federal administration. Each was analyzed to determine its effectiveness, capabilities and limitations in performing the following principal functions: (1) regulation; (2) construction; (3) financial capability; (4) operation; (5) comprehensive river basin planning; (6) evolution and amendment; and (7) ability to obtain cooperation. It is concluded that the following three types can be useful instruments in appropriate circumstances and under appropriate terms and conditions in the management of river basin resources: interstate compacts, federal-interstate compacts, and separate federal and state institutions assisted by joint federal-state planning bodies. The report recognizes that no one institution can be said to be the best for all situations and recommends that normally, before a new institutional arrangement is established in any basin, the needs of the basin should be determined and the major outlines of a basic comprehensive plan for the conservation, development, and management of the basin should be clearly seen. (Davis-Chicago)
W70-04834

CHAPTER III: REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04838

CHAPTER IV: CONTEMPORARY REGIONAL PROJECTION MODELS,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04839

CHAPTER V: PHILOSOPHY AND METHODOLOGY OF APPROACH,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04840

CHAPTER VI: THE REGIONAL SETTING OF THE STUDY,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04841

CHAPTER VII: AN OVERVIEW OF THE MODEL,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04842

CHAPTER XI: THE WATER SECTOR,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04843

MAN AND HIS URBAN ENVIRONMENT,
North Carolina Univ., Chapel Hill. School of Public Health.
Daniel A. Okun, and Stanley J. Weidenkopf.
Dept of Environmental Sciences and Engineering Publication No. 207. Presented at the Regional Conference on Improving the Physical Environment of the South, Co-sponsored by the Southern Conference of the Council on State Governments and the Agricultural Policy Institute, Atlanta, Georgia, 16-17 December, 1968, 21p, 28 ref.

Descriptors: *Environment, Social aspects, Environmental effects, Political aspects, Planning, Standards.
Identifiers: *Urban environment, *Resource reutilization, *Comprehensive environmental planning.

Focusing on the existing degradation of the environment, this paper stresses that man not only contaminates his environment, but is to a large degree the designer of his environment. After a short historical survey, the need for the reutilization of resources is stated. Several elements of the urban environment are discussed in detail including: the urban population problem, the physical environment, the social environment, and the development of environmental standards. A number of requirements for solving the problems of the urban environment are described. The first and most important requirement is an enlightened and aroused public which clearly recognizes the problem. A second requirement is a responsive political structure. A third requirement is an adequately organized and supported scientific community to determine the effect of environment on man, and man's ability to adopt to environmental changes; to establish acceptable limits; to develop effective and economical control procedures; and to educate and train future scientists for research, teaching and practice. Fourth, comprehensive environmental planning must be utilized. Finally, the implementation of planning and control programs through participation of industry, the professions, voluntary citizen's organizations and local government is essential in the formation of effective programs of environmental control. (Davis-Chicago)
W70-04846

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
North Carolina Univ., Chapel Hill. School of Public Health.
Maynard M. Hufschmidt.
University of North Carolina, School of Public Health, Department of Environmental Sciences and Engineering, Publication No 192, July, 1966, 33 p, 34 ref.

Descriptors: *Planning, *Management, *Environment, *Natural resources, *Methodology, Decision making, Public health, Aesthetics, National income, Economics.
Identifiers: *Comprehensive environmental planning, *Public investment decision model.

The concept of comprehensive environmental planning included as managing the air space, the water-resource and the land-space, in terms both of handling pollution and wastes, and of urban design. Three fundamental issues are raised. First, what are the underlying goals or objectives of comprehensive environmental planning. Second, who are the environmental planners, or who should they be. Third, what planning theories, processes and techniques are appropriate. Three goals or objectives were identified: (1) plysical and mental health, (2) aesthetics, and (3) national income (or regional or class income). Three groups have assumed the role of environmental planners in the past; environmental scientists, environmental designers and social scientists. However, the task must be shared by all in the application of social science theory and technique to environmental problems, through combined research by the three groups mentioned above. The final issue is addressed by the suggestion that the public investment decision model be adopted, and that the problems of environmental planning be examined in terms of this model. The application of this model is discussed considering various approaches: standards, multiple standards-classification, safe minimum standard, system optimization, economic efficiency, and multiple objectives. Several methodological problems are discussed as well: (1) definition of the production function; (2) the cost-input function; (3) derivation of the benefit-output function; and (4) the objective function. (Davis-Chicago)
W70-04847

MANAGING THE GREAT LAKES WATER RESOURCE,
North Carolina Univ., Chapel Hill. School of Public Health.
Daniel A. Okun.
Dept. of Environmental Sciences and Engineering, Publication No 195. For presentation at the Annual Conference of the Water Pollution Control Federation, Chicago, Illinois, September 24, 1968, 8 p, 6 ref.

Descriptors: *Management, *Water resources, *Great Lakes, Lakes, Water pollution, Water quality, Water pollution control, Diversion, Water reuse.
Identifiers: *Hierarchy of water quality, Chicago (Ill).

The Great Lakes constitute the largest fresh water resource in the world. Because there are no large

rivers that drain into the Great Lakes Basin, and because the intensity of development is expected to accelerate due to urban growth, the urgency for sound management of this water resource is clear. Changes in water quality in the Great Lakes have tended to deteriorate, especially in the lower lakes. A steady increase in the concentration of chemicals indicative of increased man-made pollution has been identified. Two proposals for improving the quality of water in the Great Lakes can be explored. First, large scale improvement of water quality can be obtained through the diversion of effluents to other water bodies. The classic example is the City of Chicago whose wastewater is diverted into the Mississippi River system. Second, a hierarchy of water quality could be adopted. Much of the water needs in the Great Lakes Basin could be served by reclaimed wastewaters. In addition, the reclaiming process would serve to improve the quality of the initial effluents. (Davis-Chicago)
W70-04848

BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
Raleigh Spinks.
Chicago City Planning Department, January 1961. 63 p, 7 fig, 39 ref.

Descriptors: *Lake Michigan, *City planning, *Islands, Urbanization, Planning, Attitudes, Social aspects.
Identifiers: *Chicago, *Policy making.

This paper attempts to provide background material relating to the creation of offshore islands in Lake Michigan near Chicago. Four main areas are covered: (1) Local planning considerations, where the concept of whether islands are a good idea in light of the Chicago Comprehensive Plan and where conflicting existing and proposed developments, conflicting public and private interests, and local approvals required are examined; (2) government policies and regulations are examined at different levels that govern the use of lake land; (3) engineering aspects of design and cost are analyzed; and (4) existing and proposed island projects in the Chicago region are described. It is the major conclusion of this paper that there appears to be no governmental, engineering or financial facts that would hold back the realistic development of islands in the lake. It appears that under the right circumstances, the free market would allow the islands to be built on a competitive basis. The major drawback appears to be the gap between what is technically feasible from an engineering and financial viewpoint and what is acceptable by the public, or understood by the public. In conclusion, preliminary research indicates that the question of islands in the lake is a city planning 'policy and values' problem rather than an engineering or financial problem. (Davis-Chicago)
W70-04899

THE WATER SITUATION,
Arizona State Water Engineer; and Arizona Interstate Stream Commission.
For primary bibliographic entry see Field 03B.
W70-04914

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
Arizona Conservation Council.
For primary bibliographic entry see Field 03B.
W70-04917

NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
American Society of Civil Engineers. Washington, D.C. National Capitol Section.

Available from Dean C. Pappas, Secretary, National Capitol Section, ASCE, c/o Board of Engineers for Rivers and Harbors, Second and Q Sts, S.W., Washington, D.C. Proceedings of Spring 1968 Water Resources Conference, Catholic University, Washington, D.C., May 11, 1968. American Society of Civil Engineers, National Capitol Section, Washington, D.C., 1969. 42 p.

Descriptors: *Evaluation, *Water policy, *Cost sharing, *Social needs, *Water resources planning act, Benefits, Federal project policy, Formulation, Future planning, Institutions, Water resources development, Cost repayment, Social values, Cost-benefit analysis, Economic efficiency.
Identifiers: *Planning objectives, Economic development, Regional development, Environmental quality.

The theme of the conference was on national policy problems. The interdisciplinary approach to these problems was emphasized by the physical, economic, financial, ecologic, sociologic, and political interrelationships discussed. Major topics dealt with water resources development in the context of total social needs, cost sharing and repayment, the viability of current institution, evaluation of outputs, future planning, and changes needed in national water policies. Principal speakers were Senator Frank E. Moss, Theodore M. Schad, Burnham H. Dodge, James J. Flannery, Philip M. Glick, Charles Howe, Lyle E. Craine, and John D. Whisman. The Conference was sponsored by the Water Resources Committee, National Capitol Section, ASCE, at the Catholic University, Washington, D.C. on May 11, 1968. (Blanchard-ASCE)
W70-04978

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
Texas A and M Univ., College Station. Water Resources Inst.
Warren L. Trock.
Available from the Clearinghouse as PB-190 361, $3.00 in paper copy, $0.65 in microfiche. Technical Report No 22, Water Resources Institute, Texas A and M University, August 1969. 76 p, 27 tab, 3 fig, 48 ref. OWRR Project B-005-TEX.

Descriptors: *Irrigation, *Economic impact, *Evaluation, Water development, Water supply, Resource economics, Optimum resource use, Linear programming.

Estimation of the effects on agriculture of alternative levels of water development in Texas was accomplished in this study. Use of land and water resources in crop production with variable total supplies of irrigation water was projected to 1980, 2000, and 2020. Constraints on output were established as Texas' shares of U.S. food and fiber requirements. Constraints on water supplies were developed by state water planners. It was concluded that without further water development, irrigated acreage in Texas would decline over time and Texas' shares of some U.S. good requirements would diminish.
W70-04983

THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
Robert F. Klausner.
Engineering Economist, Vol 14, No 4, p 183-214, July-August 1969. 32 p, 4 fig, 3 tab, 11 ref.

Descriptors: *Risks, *Mathematical models, *Simulation analysis, *Capital, *Investment, Return (Monetary), Decision making, Probability, Economic justification.
Identifiers: Cash flow.

Mathematical models for solving problems of uncertainty and risk in the evaluation of capital investment opportunities were discussed. Traditionally used techniques were found to be deficient because they did not provide an overall indicator of outcome variability or a consistent framework for analysis. They therefore resulted in a qualitative 'feel' rather than a quantitative assessment of risk. The Probabilistic Cash Flow Simulation technique was recommended over the simple Discounted Cash Flow analysis technique. In addition to indicating the discounted cash flow return, the method also showed the probability associated with realizing the investor's minimum acceptable return. The Probabilistic Cash Flow Simulation technique thus provided the decision-maker with the risk return information necessary for him to establish an investment's economic desirability. It was suggested that the technique would prove valuable in the evaluation of future marine capital investments. (Thiuri-Cornell)
W70-04990

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION; PART I. VIEWS FROM THE ACADEMY.
Western Agricultural Economics Research Council, Denver, Colo. Committee on the Economics of Water Resources Development.

Water Resources and Economic Development of the West, Report 17: Discount Rate in Public Investment Evaluation, Part I: Views from the Academy. p 1-82, 1968. 21 tab, 1 fig, append.

Descriptors: *Water resources development, *Discount rate, *Decision making, *Project planning, *Investment, Arid lands, Federal government, Water policy, Interest rate, Budgeting, Economic justification, Economics, Planning, Programs, Social aspects, Social values, Cost-benefit analysis, Cost-benefit ratio, Social impact.
Identifiers: *Western U. S., *Opportunity cost, Sensitivity analysis, Planning, Programming and Budgeting System (PPBS).

The decision of where and when to invest public funds is frequently influenced by choice of which discount rate to apply to economic analysis of the proposed program. This is of particular relevance to public investment in water resource development programs for the arid western U.S., where benefit-cost analysis has been employed for many years. With increasing utilization in recent years of the Planning, Programming and Budgeting System (PPBS) for public decision making, the discount rate has assumed increasing importance in allocation of public investment funds. Four academic exponents present diverse opinions on subjects such as measurement of the social opportunity cost of public funds; changes in discount rate over a period of time; measurement of the opportunity cost of private investment and proposal of this measurement as proper for determining public discount rate; relationship between the opportunity cost of displaced private spending and the social discount rate; and the proposal that projects be evaluated with alternative discount rates and results of a sensitivity analysis. (Crouse-Ariz)
W70-04903

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II; VIEWS FROM THE FEDERAL GOVERNMENT: A PANEL DISCUSSION,
Western Agricultural Economics Research Council, Denver, Colo. Committee on the Economics of Water Resources Development.
Harry A. Steele, Jim T. Casey, Charles F. Lemon, B. J. Tofani, and Kenneth J. Bousquet.
Water Resources and Economic Development of the West, Report 17: Discount Rate in Public Investment Evaluation, Part II: Views from the Federal Government: A Panel Discussion. p 83-106, 1968. 1 tab, 1 fig.

Descriptors: *Water resources development, *Discount rate, *Decision making, *Project planning, *Investment, Economic impact, Arid lands, Federal government, Soil conservation, Land reclamation, Multi-purpose projects, Water

policy, Interest rate, Budgeting, Economic justification, Economics, Planning, Programs, Social values, Cost-benefit analysis, Cost-benefit ratio.
Identifiers: *Western U. S., *Opportunity cost.

A panel of government officials representing major water resource development agencies such as Bureau of Reclamation, Soil Conservation Service, Department of the Army Corps of Engineers and U.S. Senate Committee on Appropriations discuss application of discount rate in project planning and their agency's views and experience. It is apparent that the difference between rates established by opportunity cost of private investment and those of social time preference is so great that the choice of either would drastically change formulation of water resource plans. This would have particular impact in the semiarid and arid Western U.S. where major water resource developments have long been evaluated on the basis of the coupon rate on long term government bonds. However, government financing policy has tended to keep the coupon rate very low in relation to the real average yield rate on all government securities. Attempts to establish guidelines for arriving at realistic and socially acceptable discount rates present a real challenge to planners and economists and will have great effect on water resource development programs. (Crouse-Ariz)
W70-04904

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
Western States Water Council.
For primary bibliographic entry see Field 04C.
W70-04913

6D. Water Demand

FORECASTING MUNICIPAL WATER REQUIREMENTS, VOLUME I - THE MAIN II SYSTEM, VOLUME II - THE MAIN II SYSTEM USER'S MANUAL.
Hittman Associates, Inc., Columbia, Md.

Available from the Clearinghouse as PB-190 275 (Vol I), PB-190 276 (Vol II), $3.00 each in paper copy, $0.65 each in microfiche. Hittman Associates Inc., HIT-413, September 1969. Vol. I, 208 p.; Vol. II, 425 p. OWRR Project C-1396.

Descriptors: *Water requirements, *Forecasting, *Municipal water, Water demand, Computer models, Statistical models, Computer programs, Regression analysis, Water management (Applied), Water utilization, Water demand, Evaluation, Cities.
Identifiers: Metropolitan water requirement model, Baltimore (Md), Baton Rouge (La), Columbia (Md).

A previously developed computer model of municipal water requirements, the MAIN I System, was used as a basis for a study of forecasting methods. The economic and demographic parameters of municipal water use were determined and their growth patterns analyzed. Data from 50 metropolitan areas were used to develop statistical models of the growth of these parameters. The models and other projection techniques were combined into a comprehensive forecasting method, named the MAIN II System. A computer program was prepared which incorporates the water requirements model as well as the forecasting system. Information required to prepare a water requirements forecast for an urban area is confined to readily available economic, demographic, and land--use data, and forecasts include detailed estimates for up to 200 water user categories. The MAIN II System was used to prepare forecasts for Baltimore, Md., Baton Rouge, La., and Columbia, Md. These case studies are presented and analyzed. Volume I describes the supporting research and the case studies. Volume II is a User's Manual, presenting a complete listing and flow chart of the computer program and giving detailed instructions for data preparation and use of the program. (See also W70-04691, W70-04692, W69-03201 and W69-03202). (Boland-Hittman)
W70-04690

MAIN C: COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SYSTEM DOCUMENTATION.
Hittman Associates, Inc., Columbia, Md.

Available from the Clearinghouse as PB-190 277 (Vol. I), and PB-190 278 (Vol. II), $3.00 each in paper copy, $0.65 each in microfiche. Hittman Associates Inc., HIT-409, August 1969. Vol I, 116 p.; Vol II, 313 p. OWRR Project C-1397.

Descriptors: *Water conservation, *Municipal water, Water requirements, *Economic impact, Computer models, Computer program, *Evaluation, Water utilization, Water management (Applied), Cities.

Existing literature and limited field studies were used to estimate, for each of 137 user categories, water use by purpose (kitchen, laundry, sanitary, cooling and condensing, etc.). These estimates were used to develop a computer model of municipal water use. Proposed water conservation devices, processes, or practices can be described in terms of their influence on water use for each purpose within each user category, and the computer model used to estimate the impact on the water demands of the entire community. A method for analyzing the economic impact of the water conservation measure is included in the model. Implementation costs, reductions in water utility operating costs, deferment of capital investments, and changes in revenue are included in the economic analysis. Volume I describes the supporting research and the design of the computer model. Volume II is a User's Manual, presenting a complete listing and flow chart of the computer program and giving detailed instructions for data preparation and the use of the program. (See also W70-04690, W70-04692, W69-03201 and W69-03202). (Boland-Hittman)
W70-04691

MAIN I: A SYSTEM OF COMPUTERIZED MODELS FOR CALCULATING AND EVALUATING MUNICIPAL WATER REQUIREMENTS -- ADDENDUM TO FINAL REPORT.
Hittman Associates, Inc., Columbia, Md.

Available from the Clearinghouse as PB-190 272, $3.00 in paper copy, $0.65 in microfiche. Hittman Associates, Inc., Addendum to HIT-336 (W69-03201, W69-03202; PB-182 555, PB-182 556), October 1969. 58 p. OWRR Project C-1397.

Descriptors: *Water requirements, *Municipal water, Water demand, Computer programs, Computer model, Water management (Applied), Water utilization, Evaluation, Cities.
Identifiers: Metropolitan water requirement model, Baton Rouge (La), Anne Arundel County (Md), Baltimore (Md), Park Forest (Ill).

A computer model of municipal water requirements was developed under a previous program and named the MAIN I System. Experience with the application of this model in estimating current water requirements for Baton Rouge, La., Anne Arundel County, Md., Baltimore, Md., and Park Forest, Ill., led to modifications and improvements. This addendum reports these applications and documents the changes in the estimating method which resulted. Comments received on the original report are also reviewed and additional information presented on the basis of the computer model. Where actual water demand data were available, various estimates of demand for the cities studied were from 12.6 percent below to 2.5 percent above actual demands. Estimates for specific user categories and for specific months and seasons were also in close agreement. (See also W70-04690 and W70-04691) (Boland-Hittman)
W70-04692

PETROLEUM INDUSTRY IN ILLINOIS, 1968: PART 2. WATERFLOOD OPERATIONS,
Illinois State Geological Survey, Urbana.
T. F. Lawry.
Illinois State Geological Survey Illinois Petroleum 92, p 67-122, 1969. 56 p, 5 tab.

Descriptors: *Oil fields, *Illinois, *Flooding, *Injection wells, *Secondary recovery (Oil), Injection, Oil reservoirs, Brines, Saline water, Water utilization, Water demand.
Identifiers: Oil field waterflooding.

Forty-four new waterfloods were added in Illinois oil fields in 1968 while 50 waterfloods were abandoned and 12 waterflood listings were dropped for lack of data or because they were combined with other waterfloods. The area subject to fluid injection was increased by 11,500 acres in the new waterflood projects, and by 3600 acres in the expansion of older waterflood projects. Acreage subject to fluid injection is now approximately 47.7 of the total pay acreage in the state. (Knapp-USGS)
W70-04737

QUANTITATIVE ANALYSIS OF RESIDENTIAL WATER-USE PATTERNS IN MAYAGUEZ, PUERTO RICO,
Puerto Rico Univ., Mayaguez. Water Resources Research Inst.
Ausberto Guilbe.
PB-190 439. Water Resources Research Institute, School of Engineering, Mayaguez, Puerto Rico, June, 1969. 96p, 44 tabs, 20 fig, 3 append, 10 ref.

Descriptors: *Water utilization, *Correlation analysis, Computer models, Statistical models, Social aspects.
Identifiers: Mayaguez, Puerto Rico.

A practical functional relationship model to correlate residential water use with socio-economic factors which are known to influence the water usage is developed. The data was obtained from sample surveys. The collected data was subject to analyses in order to disclose the form of the relationship between water use and influencing factors. It was found that the influencing factor or independent variable is property value. Water use is the dependent variable. The property value was used as an indirect practical indicator of other factors. With regard to public dwellings it was found that the number of bedrooms, rather than property value, served as a significant independent variable. The computer program used in analyzing the data is included. (Grossman-Rutgers)
W70-04830

CHAPTER VI: THE REGIONAL SETTING OF THE STUDY,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04841

CHAPTER XI: THE WATER SECTOR,
Battelle Memorial Inst., Columbus, Ohio; Indiana Univ., Bloomington; Massachusetts Inst. of Tech., Cambridge; and Chicago Univ., Ill.
For primary bibliographic entry see Field 06A.
W70-04843

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
For primary bibliographic entry see Field 06E.
W70-04877

DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
Norwegian Water Resources and Electricity Board, Oslo.
For primary bibliographic entry see Field 06A.
W70-04991

6E. Water Law and Institutions

ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
Water Resources Council, Washington, D.C.
For primary bibliographic entry see Field 06B.
W70-04834

MAN AND HIS URBAN ENVIRONMENT,
North Carolina Univ., Chapel Hill. School of Public Health.
For primary bibliographic entry see Field 06B.
W70-04846

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Study Committee, 1968. 262 p, 746 ref, append.

Descriptors: *Indiana, *Water law, *Legislation, *Water rights, State governments, Local governments, Planning, Administrative agencies, Judicial decisions, Riparian rights, Public rights, Navigable waters, Non-navigable waters, Prescriptive rights, History, Lakes, Ponds, Streams, Legal aspects, Watercourses (Legal), Surface waters, Groundwater, Geographical regions, Spring waters, Artificial precipitation, Publications, Surveys.
Identifiers: *Legislative reports, *Studies.

The Indiana Water Resources Study Committee instituted this study and report on the existing law of water rights in Indiana. Chapter one examines private rights in water and deals in subdivisions with: (1) the physical setting and uses of Indiana's water; (2) riparian rights in surface watercourses; (3) the appropriation doctrine; (4) differences with respect to navigable and non-navigable watercourses; (5) differences with respect to streams, lakes, and ponds; (6) rights to diffused surface water; (7) rights to groundwater; (8) rights to use spring water and artificially developed waters; (9) the effect of rainmaking on water rights; (10) prescriptive rights; (11) transfer of water rights; and (12) remedies to protect water rights. Chapter two examines public rights in water and deals in subdivisions with: (1) general public rights; (2) early and recent judicial developments; and (3) statutory developments. Chapter three examines the impact on Indiana water law of administrative agencies and local units of government and, within the framework of two major subdivisions, deals at length with Indiana water administrative agencies, and with the role of local government in the shaping of Indiana water rights. (See also W70-04858 thru W70-04869). (Marsee-Florida)
W70-04857

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Study Committee, p 1-5, 1968.

Descriptors: *Indiana, *Hydrogeology, *Riparian land, *Watercourses (Legal), Riparian rights, Groundwater, Glaciers, Geomorphology, Lakes, Lake forming, Rivers, Streams, Terrain analysis, Topography, Irrigation effects, Irrigation, Water sources, Use rates, Water utilization, Recreation demand, Legal aspects, Judicial decisions, State governments, Regions, Slopes, Great Lakes Region.

Most of Indiana is from 500 to 1,000 feet above sea level. Generally hillier in the south than in the north, the land tilts slightly to the southwest, so that most of Indiana's streams and rivers flow southwest and ultimately into the Mississippi. The geology is varied and includes many remnants of glacial lakes. Thick glacial deposits are the state's most important source of groundwater. Both ground and surface water are readily available and usually plentiful; however, it is estimated that by 1975 an increasing population, irrigation needs during dry seasons, recreational demands, and other potential needs will double the volume of water used in 1954. In Indiana private water rights are governed by modifications of the riparian rights doctrine although there are few cases dealing with riparian rights in Indiana. 'Riparian land' has not been defined in this state although a statute not yet interpreted could be a basis for such definition. One Indiana court has attempted to broadly define 'watercourse' in terms of substantial existence and unity, and regularity and dependability of flow along a definite course. (See W70-04857). (Marsee-Florida)
W70-04858

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Study Committee, p 5-11, 1968.

Descriptors: *Indiana, *Riparian rights, *Natural flow doctrine, *Reasonable use, Alteration of flow, Artificial use, Domestic water, Legal aspects, Legislation, Judicial decisions, Obstruction to flow, Relative rights, Riparian waters, Usufructuary right, Waste disposal, Irrigation, Impoundments, Consumptive use, Agriculture, State governments, Social values, Social impact.

The riparian rights doctrine, as first set forth, gave the riparian owner a right to the undiminished, unaltered, natural flow of a watercourse. Were this natural flow doctrine strictly applied, it would prohibit all consumptive uses of water. Indiana has developed the more pragmatic doctrine of 'reasonable use.' This doctrine allows reasonable interference with natural flow. Whether a particular use is reasonable is a question of fact and will depend upon the circumstances in the particular case. Some jurisdictions distinguish between domestic and artificial uses, allowing the riparian owner to satisfy his domestic needs even to the detriment of downstream riparians. Indiana case law has not recognized this distinction, but a recent statute has. Indiana courts have occasionally shown a reluctance to test the reasonableness of a commercial use by the social value of such use. Where a lower riparian owner causes water to back up onto the land of an upper riparian owner the courts have strictly held the lower riparian owner liable for all damages. (See W70-04857). (Marsee-Florida)
W70-04859

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Study Committee, p 11-17, 1968.

Descriptors: *Indiana, *Prior appropriation, *Navigable waters, *Non-navigable waters, Riparian rights, Navigation, Rivers, Running waters, Streams, Ownership of beds, River beds, Public rights, Legal aspects, Federal government, Federal jurisdiction, Lakes, Watercourses (Legal), Priorities, Water rights, Preferences (Water rights), Judicial decisions, Legislation, State governments.

The report provides a survey description of the western appropriation doctrine and mentions similarities between that doctrine and Indiana's riparian rights doctrine. Indiana differentiates between navigable and non-navigable watercourses. Whether water is navigable or non-navigable is relevant in deciding questions of bed ownership, public rights of use, and federal regulation in particular bodies of water. Since 'navigable' does not have the same meaning in all these contexts, it becomes important to define the context in which the term is being used. Navigability is important in two situations concerning private rights. First, in deciding ownership of beds in Indiana it is necessary to know whether the body of water was navigable at the time statehood was attained. Second, if a particular body is navigable, riparian rights are subordinate to a public right of navigation. (See W70-04857). (Marsee-Florida)
W70-04860

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Study Committee, p 17-22, 1968.

Descriptors: *Indiana, *Navigable waters, *Non-navigable waters, *Ownership of beds, Navigation, Federal government, Legal aspects, State governments, Judicial decisions, Streambeds, Rivers, Lakes, Streams, Federal jurisdiction, Riparian rights, Public rights.
Identifiers: *Navigability tests.

To decide who owns the bed of a lake, river, or stream in Indiana, it is necessary to know whether that body of water was navigable at the time the area became part of a state. The general rule provides that bed title passed to the state at that time if the water was navigable, but remained in the public if the water was non-navigable. Questions of bed ownership, such as the demarcation of the bed from the upland, and of navigability are federal questions. The federal test of navigability is one of fact, turning upon whether the waters are susceptible of being used in their ordinary and natural condition as highways for commerce. These commercial tests are capable of change with time and demand. For instance, recreation is a significant commercial use today but was not at the time of Indiana's admission to the Union. The most recent Indiana Supreme Court case on the relation of navigability to bed ownership adopted the federal rule on navigability, but this did not substantially change Indiana law. The Indiana common-law test was virtually the same as the federal test. (See W70-04857). (Marsee-Florida)
W70-04861

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Water Res Committee, p 22-25, 1968.

Descriptors: *Indiana, *Riparian rights, *Ownership of beds, *Public rights, Navigable waters, Non-navigable waters, Streams, Ponds, Lakes, Rivers, Land tenure, Federal government, State governments, Judicial decisions, Legislation, Legal aspects, Relative rights, Piers, Wetlands, Streambeds, Federal jurisdiction, Water rights, Riparian land.

When a body of water is navigable according to the federal test, the state wherein the water is situated has title to the bed. If the water is non-navigable, bed title is in the owner or owners of the adjoining land. There is a presumption that a grant of land adjoining non-navigable water carries title to the bed. It is well established in Indiana that the owner of a bed beneath such non-navigable waters may control the waters above the bed as if it were his land. Where waters are navigable, a riparian owner's rights are subject to a public right of navigation. The riparian owner may not unreasonably interfere with the right of navigation although he may build wharves which do not interfere with that right. Unlike bed-ownership problems, the public right of navigation does not require the application of federal law. Therefore the Indiana common-law test of navigability is applied. Although there may be some differences between public rights in lakes and those recognized in streams, Indiana seems to make no distinction between lakes, ponds, and streams with respect to riparian rights. (See W70-04857). (Marsee-Florida)

W70-04862

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 25-30, 1968.

Descriptors: *Indiana, *Surface runoff, *Repulsion (Legal aspects), *Riddance (Legal aspects), Judicial decisions, Legal aspects, Runoff, Drainage water, Overland flow, Surface drainage, Surface waters, Drainage, Impounded waters, Impoundments, Diversion, Water pollution, Great Lakes Region, Water rights, Relative rights, Land use, Real property, Alteration of flow.

The distinguishing characteristic of diffused surface water is that it has no definite banks or channel as does surface water. Indiana follows the general rule that diffused surface water belongs to the person who captures and collects it on his land. Most of the legal problems related to diffused surface water involve attempts by landowners to rid themselves of such water by altering the natural drainage pattern so as to divert the water onto another's land. The liability of a landowner for such alteration in Indiana is determined by the common-enemy rule, subject to several modifications. The early common-enemy rule gave an owner unqualified right to do what he wished with diffused surface water including altering its course. This rule has been qualified in Indiana so that: (1) a landowner may not collect and then discharge such water; (2) a lower landowner may not collect surface water in an artificial channel and force it back upon upper land; (3) a landowner may not concentrate nor increase the flow onto other's land; and (4) he may not pollute such water. (See W70-04857). (Marsee-Florida)
W70-04863

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 30-40, 1968.

Descriptors: *Indiana, *Groundwater, *Overlying proprietor, *Percolating water, Underground streams, Legal aspects, Judicial decisions, Relative rights, Water utilization, Subsurface waters, Underflow, Groundwater basins, Groundwater movement, Hydrologic cycle, Soil water, Reasonable use, Water rights, Reservoirs, Underground, Water sources.

A brief introduction to the law of groundwater is given, noting the distinction often made between underground streams and percolating water. Three doctrines define private rights to groundwater. The 'absolute ownership' doctrine holds that groundwater is part of the land on which it is found, and that the landowner has an absolute right to the water, provided he does not maliciously injure his neighbor. The 'reasonable use' doctrine, also proceeds upon the assumption that groundwater is part of the land; it limits the landowner to reasonable use of the water. The 'correlative rights' doctrine gives all owners of land over a common supply of groundwater correlative rights to the reasonable use of such water, provided they use it on overlying lands. In Indiana, the law of groundwater is unsettled. Early cases adopted the absolute ownership view. However, the later case of Gagnon v French Lick Springs Hotel Co., 163 Ind 687, 72 NE 849 (1904) makes it unclear whether Indiana still follows that view. An analysis of the case indicates that it probably has not changed the earlier Indiana law. (See W70-04857). (Marsee-Florida)
W70-04864

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 40-54, 1968.

Descriptors: *Indiana, *Water rights, *Prescriptive rights, *Adjudication procedure, Conjunctive use, Natural flow doctrine, Riparian rights, Competing uses, Land tenure, Legal aspects, Judicial decisions, Relative rights, Water law, Water transfer, Water utilization, Consumptive use, Spring waters, Artificial precipitation, Water sources, Public rights, Damages.
Identifiers: Injunctions.

There are no Indiana cases dealing with: (1) the right to use spring waters; (2) the right to use artificially developed waters; (3) rights affected by rainmaking; or (4) the effect upon water rights of the interrelationship of water sources. In Indiana, water rights may be acquired by prescription except that there may be no acquisition of a prescriptive right in public waters. The elements of prescription in Indiana are discussed. Two examples of prescriptive water rights recognized in Indiana are the acquisition of an easement for drainage across another's land, and a right to maintain an unnatural condition which affects a watercourse. Certain prescriptive rights problems relating to consumptive use by riparian and non-riparian owners have not yet arisen in Indiana. Rights to water in Indiana may be conveyed separately, but these rights pass with the land unless reserved by the land's transferor. Indiana case law has recognized the following remedies to protect water rights: (1) damages; (2) injunction; (3) summary abatement or self-help; (4) apportionment or partition; and (5) declaratory judgment. (See W70-04857). (Marsee-Florida)
W70-04865

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 77-92, 1968.

Descriptors: *Indiana, *Public rights, *Navigation, *Judicial decisions, Legal aspects, Water law, Recreation, Fishing, Navigable waters, Lake Michigan, State governments, Non-consumptive use, Riparian rights, Transportation, Water allocation (Policy), Lakes, Streams, Rivers, Watercourses (Legal), Streambeds, Riparian waters, Navigable rivers, Relative rights, Ice.
Identifiers: Northwest Ordinance.

Public water rights in Indiana are outlined within the framework of early and recent judicial developments, with special emphasis on key cases. Early cases almost invariably dealt with commercial, as opposed to recreational, navigation. These cases viewed the Northwest Ordinance as prohibiting physical obstructions of navigable watercourses. Today, court-made public rights in water exist in watercourses which are susceptible to commercial navigation. The Indiana courts have not customarily used the trust doctrine in judicially defining public rights. Public rights are not paramount to all private or state activities; the courts tend to take a balancing-of-interests approach. Thus, state authorized uses may be allowed at the expense of public rights. With a few exceptions, public rights in water do not limit riparian uses of the banks that do not physically obstruct navigation. The common-law public right includes removing sand from Lake Michigan's bed and probably from other streambeds. It probably includes recreational uses as well, although there has been no specific judicial determination of this. The public right is expressed as an easement of passage free from artificial obstruction. (See W70-04857). (Marsee-Florida)
W70-04866

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 92-108, 1968.

Descriptors: *Indiana, *Legislation, Public rights, *Riparian rights, Lakes, Rivers, Streams, Riparian land, Ditches, Recreation, Recreation demand, Legal aspects, State governments, Navigable waters, Non-navigable waters, Impoundments, Consumptive use, Non-consumptive use, Navigation, Lake Michigan, Lake shores.

Although there is little case law in Indiana concerning public rights in water, there are many statutes. In 1955, water in any natural watercourse which may be applied to any 'useful and beneficial purpose' was declared to be public water of the state and subject to legislative regulation for the public welfare. It is unclear whether the phrase 'useful and beneficial' purposes includes recreation; however, two 1947 statutes declaring public rights broadly indicate that the right of recreation is a public right in water. The 1955 statute did limit the public right by subordinating such right to domestic uses and impoundments by riparian owners. The 1947 statutes do not make public rights depend on navigability. Apparently any use by the public is sufficient if acquiesced in by any riparian. This creates a constitutional problem concerning the exercise of the state's police power. Other statutes deal with: (1) zoning lakes for public use; (2) the power of county commissioners to declare waters in their counties navigable; and (3) the empowering of town trustees to determine and regulate the banks, shores, and wharves of any stream within the corporate limit. (See W70-04857). (Marsee-Florida)
W70-04867

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 120-210, 1968.

Descriptors: *Indiana, *Administrative agencies, *State governments, *Water resources development, Legal aspects, Coordination, Institutions, Organizations, Permits, Regulation, Water allocation (Policy), Water rights, Public rights, Administration, Water law, Administrative decisions, Adoption of practices, Decision making, Leadership, Legislation, Judicial decisions, Standards, Water policy, Water zoning, Political aspects.

The impact of administrative agencies and local government units on Indiana water law is considered. The development of Indiana statutory law is discussed in light of: (1) the shift in water policy-making from local to state units of government; (2) the supplanting of court-made doctrine with legislation as a basis for determining important private and public rights in water; (3) and the emphasis placed on research by the Indiana Water Resources Study Committee. Two important Indiana water administrative agencies, the Division of Water of the Department of Natural Resources and the Stream Pollution Control Board, are discussed with emphasis placed upon the powers, responsibilities, and sources of authority of the former. Also discussed are the general administrative structures of the two agencies, and those integrating factors which draw the agencies together. Consideration is given to other state agencies with powers relating to water use, including the State Board of Health and the Public Service Commission. (See W70-04857). (Marsee-Florida)
W70-04868

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
G. Graham Waite.
Indiana Res Study Committee, p 210-262, 1968.

Descriptors: *Indiana, *Local governments, *Coordination, *State governments, Zoning, Legal aspects, Legislation, Municipal water, Water law, Political aspects, Public rights, Judicial decisions, Conservation, Water districts, Governments, Navigable waters, Lakes, Drainage, Assessment, Non-navigable waters, Flood control, Administrative agencies.
Identifiers: Counties, Public trust.

An examination is made of the role of local government in shaping water rights in Indiana. Areas which are discussed include: (1) the working relationships between local units and state agencies in the water field; (2) statutory delegation of water-related powers to local units; (3) Indiana's conservancy districts; (4) the delegability of the public

trust in navigable waters to local units; (5) municipal zoning and use of water; and (6) water use problems in the six Indiana counties of Marion, Delaware, Kosciusko, Knox, Washington, and Monroe. An appendix to the overall report discusses the scope of Indiana's Lake Level Act. (See W70-04857). (Marsee-Florida)
W70-04869

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS: MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
Robert E. Beck.
Texas Law Review, Vol 46, no 2, p 180-212, Dec 1967. 33 p, 113 ref.

Descriptors: *Riparian rights, *Dry beds, *Water level fluctuations, *Accretion (Legal aspects), State governments, Banks, Riparian land, Navigable waters, Ownership of beds, Riparian waters, Riparian water loss, Bank stability, Lakes, Beds under water, Beds, Lake beds, Boundaries (Property), High water mark, Low water mark, Compensation, Water levels, Fluctuation, Bodies of water, Ponds, Recreation facilities, Water resources development.
Identifiers: *Water level maintenance.

With proposals for refilling and artificially maintaining water levels of lakes and ponds for recreation purposes, there arises the problem of compensation for riparian landowners who would have become entitled to alluvion that would have formed but for the refilling. The initial question is whether the riparian right to alluvion, especially the right to future alluvion, is property. Authority is split on the question of the right to alluvion as a vested right, so the decision must be one of policy. The interest of the state in its water resources is placed opposite the interests of the riparian in the land and in having access to the waters. Since a property right may exist, the state may argue that it has not damaged the riparian's property rights by relying on either its interests in the waters within the state or its ownership of the bed under the waters. Under certain circumstances the property right may be properly taken or damaged, but the problem of compensation is complicated by problems in predicting how much alluvion was lost and what its value would have been. (See also W70-04871 thru W70-04873). (Douberley-Florida)
W70-04870

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS: MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
Robert E. Beck.
Texas Law Review, Vol 46, no 2, p 180-189, Dec 1967.

Descriptors: *Riparian rights, *Dry beds, *Water level fluctuations, *Accretion (Legal aspects), Flooding, Riparian land, Recreation facilities, Lakes, Beds, Lake beds, Boundaries (Property), Water levels, Bodies of water, Ponds, Recreation, Relative rights, Flood damage.
Identifiers: *Water level maintenance.

There have been proposals for refilling and artificially maintaining water levels of lakes and ponds for recreational purposes; these projects, however, often would result in flooding abutting land. One of the littoral rights of adjacent landowners is the right to alluvion bared by reliction and accretion. There is some question whether inundation caused by refilling or maintaining levels should be considered as a taking of property that would require compensation. Courts are split on whether the riparian right to alluvion, especially to future alluvion, is a vested property right. Cases that treat the right to alluvion as a property right do not deal with future alluvion. Many courts take a 'lump-sum' approach that considers all riparian rights together and attempts to put them into existing classifications of property interests. A 'separate-evaluation' approach is more useful. This approach looks at each component of riparian rights separately and classifies each separately. Some riparian rights might be treated as vested property rights if separately evaluated, while others would be considered only contingent. A few cases hold that the right to future alluvion is vested, but others reject it as a property right. (See 70-04870). (Douberley-Florida)
W70-04871

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS: MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
Robert E. Beck.
Texas Law Review, Vol 46, no 2, p 190-195, Dec 1967.

Descriptors: *Riparian rights, *Accretion (Legal aspects), *Riparian land, *Dry beds, Bank stability, Water resources development, Prior appropriation, Recreation, Recreation facilities, Water sources, Groundwater, Acess routes, State governments, Riparian water loss, Water levels, Fluctuation, Water rights.

Some states do not include the right to future alluvion in their list of recognized riparian rights. The western states reject the concept of riparian rights altogether. The decision of whether the right is considered vested or is treated as a mere contingency is one of policy, requiring the interests of the state to be balanced against those of the individual. The state has an interest in the maximum use of water, especially in light of increasing demands on water for recreational purposes. The task of restoring water levels rests with the state as an exercise of its police power. The state either has an existing tangible public interest in some waters within its jurisdiction, or it may acquire authority through procedures similar to those used in establishing drainage districts. Since the low water levels were caused by a man-made deficit of water sources, it would not seem that the state should have to pay to restore those levels. The primary substantive right of the abutting landowner is the maintenance of his status as a riparian owner by maintaining access to the waterbody. That right would be retained by maintaining water levels. (See W70-04870). (Douberley-Florida)
W70-04872

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS: MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
Robert E. Beck.
Texas Law Review, Vol 46, no 2, p 195-212, Dec 1967.

Descriptors: *Riparian rights, *Dry beds, *Water level fluctuations, *Accretion (Legal aspects), High water mark, Low water mark, Navigable waters, Ownership of beds, Low-flow augmentation, State governments, Beds under water, Beds, Lake beds, Boundaries (Property), Compensation, Water levels, Fluctuation, Lake morphology, Lake shores, Damages, Erosion, Flood damage, Reasonable use.

The law regarding formation of alluvion is not an impediment to the state in most cases. The permanent drying up of the bed is not necessarily enough for the riparian owner to acquire rights to alluvion. The recession must be permanent, gradual and imperceptible. States may assert that there has been no taking of property by alleging either a paramount property right or by a valid exercise of the police power. Either argument requires balancing public and private interests. Each state has an interest in at least some waters within its boundaries. Levels may be artificially maintained to promote navigation, and this may be extended to include recreational uses. Further, states own at least some beds, usually under navigable waters, and maintaining the water level is a reasonable use of that bed, assuming the bed extends to the high water mark. Just compensation is difficult to determine because a determination of how much alluvion the owner has lost is highly speculative. Further, since title is frequently not quieted, value is difficult to determine. (See W70-04870). (Douberley-Florida)
W70-04873

WATER RIGHTS IN TENNESSEE,
Mahlon L. Townsend.
Tennessee Law Review, Vol 27, No 4, p 557-568, Summer 1960. 12 p, 98 ref.

Descriptors: *Ownership of beds, *Navigable rivers, *Subsurface waters, *Accretion (Legal aspects), Beds under water, Streambeds, Boundaries (Property), Low water mark, Non-navigable waters, Riparian rights, Natural flow doctrine, Alteration of flow, Civil law, Diversion, Surface drainage, Percolating water, Underground streams, Riparian land, Obstruction to flow, Reasonable use, Water pollution, Bank erosion, Dams, Natural flow, River flow, Access routes.

In Tennessee, water rights and riparian rights depend upon the navigability of the waterbody. Generally, the public retains substantial rights in navigable waters. The owner's title to riparian land may change by virtue of gradual changes due to erosion and accretion, but not by avulsion. The reasonable use doctrine applies to all riparian owners adjacent to running streams. Streams may be dammed or diverted, so long as there is no injury to other owners or substantial inconvenience to navigation. Diffused surface waters belong to owners of the beds beneath them. Natural flow from higher lands may not be obstructed, although damage caused by unnatural discharges is actionable. Underground streams are subject to the same laws as surface streams. The correlative rights doctrine applies to percolating waters that do not flow in an established channel. (See also W70-04875 and W70-04876). (Douberley-Florida)
W70-04874

WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
Mahlon L. Townsend.
Tennessee Law Review, Vol 27, No 4, p 557-564, Summer 1960. 7 p, 65 ref.

Descriptors: *Tennessee, *Surface waters, *Running waters, *Riparian rights, Navigable rivers, Streams, Bank erosion, Streambeds, River beds, Navigable waters, Stream erosion, Ownership of beds, Natural flow, Alteration of flow, River flow, Low water mark, Obstruction to flow, Civil law, Non-navigable waters, Riparian waters, Navigation, Reasonable use, Accretion (Legal aspects), Boundaries (Property), Water pollution.
Identifiers: Navigability in fact.

A stream is legally or technically navigable if it meets the civil law test; that is, if it is suitable for the usual purposes of navigation. A stream not legally navigable may become navigable in fact when flooding raises the water level. The public owns the beds of legally navigable streams; the title of riparian owners extends to the ordinary low water mark. Title to the bed of a stream only navigable in fact is in the riparian owners, subject to a public easement for navigation. A stream not navigable at all is subject to private ownership. Accretion deposited gradually becomes the property of the riparian owner, but he may lose land by erosion. Land may become riparian because of erosion, and it does not lose that status if accretion restores eroded land. Title to riparian land does not change because of rapid avulsion. A stream navigated by the public for more than twenty years may not be obstructed unless a greater public benefit is created by the obstruction. The reasona-

ble use doctrine applies to use of water by riparian owners, and reasonable diversions are allowed. A riparian owner may construct dams, but not so as to injure other riparian owners. All pollution is unlawful. (See W70-04874). (Douberley-Florida)
W70-04875

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
Mahlon L. Townsend.
Tennessee Law Review, Vol 27, No 4, p 564-568, Summer 1960. 5 p, 33 ref.

Descriptors: *Tennessee, *Surface runoff, *Surface waters, *Subsurface waters, Drainage, Drainage water, Repulsion (Legal aspects), Riddance (Legal aspects), Standing waters, Overland flow, Surface drainage, Natural flow, Discharge (Water), Prior appropriation, Excess water (Soils), Precipitation excess, Easements, Obstruction to flow, Flooding, Percolation, Underground streams, Percolating water, Channels, Reasonable use.

Diffused surface waters are those not in natural streams or channels; they flow over the land, usually following precipitation. Such waters belong to the owner of the land. The owner of an upper tract has an easement on the lower tract for drainage of diffused surface waters. The flow cannot be obstructed so as to overflow the higher land. The upper owner may not discharge unnatural quantities of water onto the lower land. Damage to a building caused by water drainage from an adjacent building is actionable. Rights to surface waters may be acquired or lost by prescription and transferred by conveyance. Underground flowing streams are subject to the law applicable to surface streams. Unless the channel is established, the waters are presumed to be percolating, and the correlative rights doctrine is applied to them. The landowner is entitled to reasonable use of the water percolating through his land. The owner of a spring or well is entitled to damages for both surface and underground pollution. (See W70-04874). (Douberley-Florida)
W70-04876

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
Glenn R. Coates.
Wisconsin Law Review, Vol 1953, no 2, p 256-296, Mar 1953. 41 p, 102 ref.

Descriptors: *Wisconsin, *Water conservation, *Water demand, *Water allocation (Policy), Water supply, Water distribution (Applied), Administration, Permits, Legal aspects, Water sources, Competing uses, Riparian rights, Reasonable use, Water policy, Domestic water, Industrial water, Recreation, Irrigation practices, Legal aspects, Surface waters, Surface irrigation, Administrative agencies, Regulation.

Conflict over water use continues to increase between irrigators and sportsmen. The former desire further consumptive use of water, while the latter oppose any dimunition of surface waters which might endanger marine life and recreation. Irrigation has recently expanded from specialty crops to grains and pastures, increasing the demand on the state's water supply. The growing Wisconsin tourist industry, on the other hand, depends to a great extent upon fishing and other water recreation. Other increases in domestic and industrial consumptive uses further complicate the problem. A review of legislation and common law water rights doctrine reveals that little has been done to uniformly regulate the competing demands upon the water supply. The author suggests adoption of the Water Diversion Act, which places authority to deal with competing uses that result in water diversion under a public service commission. Generally, permits would be required before water could be diverted from water courses or ground sources, and an overall policy of water allocation could be developed. There is evidence that sufficient economic necessity exists to support the constitutionality of this type of water control under the Wisconsin Constitution. (See also W70-04878 thru W70-04880). (Kelly-Florida)
W70-04877

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
Glenn R. Coates.
Wisconsin Law Review, Vol 1953, No 2, p 263-268, Mar 1953.

Descriptors: *Wisconsin, *Water rights, *Riparian rights, *Surface waters, Water demand, Reasonable use, Water policy, Water allocation (Policy), Competing uses, Relative rights, Streamflow, Natural flow, Administration, Judicial decisions, Legal aspects, Legislation, Regulation, Permits.

Surface waters may be defined as waters flowing continuously or intermittently in natural surface channels from definite sources of supply, and waters flowing through lakes, ponds, and marshes which are integral parts of a stream system. The flow must be of sufficient quantity to form a bed and banks. In Wisconsin, the existence of a watercourse is a question of fact for the jury. Wisconsin has exclusively adopted the doctrine of riparian rights. An owner of land contiguous to a watercourse has a right to have the water flow by or through his land substantially undiminished in quantity or quality, subject to an upper riparian owner's right to make reasonable use of the water as it flows by his land. The riparian right cannot be taken for a public purpose without compensation. Legislation gives the riparian owner full protection of his right to natural flow, but prohibits consumptive use of the water without a Public Service Commission permit. Legislation also protects public water rights. The author suggests that protective legislation has substantially diminished the privilege of reasonable use. (See W70-04877). (Kelly-Florida)
W70-04878

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
Glenn R. Coates.
Wisconsin Law Review, Vol 1953, no 2, p 268-270, Mar 1953.

Descriptors: *Wisconsin, *Prior appropriation, *Water rights, *Beneficial use, Adjudication procedure, Appropriation, Diversion, Administrative agencies, Preferences (Water rights), Industrial water, Legal aspects, Legislation, Permits, Irrigation water, Priorities, Reasonable use, Remedies, Water utilization, Usufructuary right, Regulation.

The doctrine of prior appropriation has been recognized and enforced by the courts of some states in deference to well recognized practices by laymen in a number of Western states. The doctrine provides that the right to use water arises from a diversion of water plus application of that diverted to beneficial use. Priority in time gives the better right, and location of land in respect to the watercourse is not a factor. Some states adapting this doctrine require that applications for permits be made to the state engineer before diversion of water may be commenced. The doctrine of prior appropriation is thought to be preferable to the riparian doctrine in encouraging efficient water use. There are faults in the former doctrine, however, which permit an early appropriator to divert a greater amount of water than he can efficiently use, so long as his use is beneficial. The author suggests that increased administrative regulation and more emphasis on beneficial use rather than priority would make the doctrine more workable. (See W70-04877). (Kelly-Florida)
W70-04879

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS; GROUNDWATER; AND A PROPOSED WATER DIVERSION ACT),
Glenn R. Coates.
Wisconsin Law Review, Vol 1953, No 2, p 270-296, Mar 1953.

Descriptors: *Wisconsin, *Groundwater, *Water rights, *Surface runoff, Surface-groundwater relationships, Drainage water, Base flow, Groundwater movement, Prescriptive rights, Water wells, Water supply, Water demand, Administration, Water distribution (Applied), Legal aspects, Regulation, Impoundments, Legislation, Reasonable use.

Diffused surface waters occur on the surface of the earth in places other than defined water courses, lakes, or ponds. Riparian rights do not attach to such waters. Judicial difficulties have arisen in Western states with regard to the impounding of diffused surface water which is the source of supply for a watercourse. Groundwater is construed in Wisconsin to exclude defined underground streams. Groundwater includes only percolating waters, and underground streams are treated in the same manner as surface water. A landowner may withdraw all the water he wishes by wells on his own land under Wisconsin common law. The legislature has curtailed this unrestricted use, however, and requires permits to be obtained before more than a certain daily volume of water may be withdrawn. Other states have adopted a reasonable use limitation under common law. Some states have extended appropriation principles to all groundwater, giving the greatest right to owners of the land overlying the supply. It is contended that the Wisconsin rule gives approval to destruction of groundwater levels through individual waste. (See W70-04877). (Kelly-Florida)
W70-04880

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER PROBLEMS).
For primary bibliographic entry see Field 05G.
W70-04881

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
For primary bibliographic entry see Field 05G.
W70-04882

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
For primary bibliographic entry see Field 05G.
W70-04883

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).
For primary bibliographic entry see Field 05G.
W70-04884

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
For primary bibliographic entry see Field 05G.
W70-04885

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).
For primary bibliographic entry see Field 05G.
W70-04886

NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
American Society of Civil Engineers. Washington, D.C. National Capitol Section.
For primary bibliographic entry see Field 06B.
W70-04978

6F. Nonstructural Alternatives

RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
California Univ., Berkeley. Center for Research in Management Science.
C. B. McGuire.
Available from the Clearinghouse as PB-190 270, $3.00 in paper copy, $0.65 in microfiche. California University Center for Research in Management Science, Final Report for period July 1967-March 1969. 142 p, 13 fig, 62 ref, 2 append. OWRR Proj No C-1120.

Descriptors: *Statistical models, *Non-structural alternatives, *Flood plains, *Beneficial use, *Simulation analysis, Stochastic processes, Mathematical models, Dynamic programming, Systems analysis, Social aspects, Legal aspects, Economics, Flood damage, Flood plain zoning, Planning, Probability, Investment.
Identifiers: Flood plain use.

An economic, stochastic model was studied for predicting rational investment behavior in the face of floods. A computable model was made of people's reactions, in terms of economic decisions, to changes in such things as flood control policies, flood relief policies, flood insurance, information (or beliefs) about floods and damages, production technology, available economic activities, commodity prices, and interest rates. Together with hydrological data about the stochastic nature of flood occurrences, the model then may be made to serve either prescriptive or descriptive uses; that is, either (1) to tell a landowner how he ought to behave in terms of proper choice and management of the production activity on his land, or (2) to predict how a rational landowner will behave in these same terms. (Knapp-USGS)
W70-04689

6G. Ecologic Impact of Water Development

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
Texas A and M Univ., College Station. Water Resources Inst.
For primary bibliographic entry see Field 02L.
W70-04687

07. RESOURCES DATA

7A. Network Design

THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
Geological Survey, Washington, D.C. Water Resources Div.
For primary bibliographic entry see Field 04C.
W70-04573

SENSOR DETECTION CAPABILITIES STUDY,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07B.
W70-04592

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
Geological Survey, Washington, D.C.
H. C. Riggs.
French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 540-550, 1966. 11 p, 8 fig, 14 ref.

Descriptors: *Streamflow forecasting, *Reservoir design, *Data collections, *Surveys, Networks, Stream gages, Gaging stations, Climatic data, Hydrologic data, Water storage, Reservoirs.
Identifiers: *Reservoir design data.

Definition of a draft-storage relation should be based on a streamflow record of considerable length from a network of stream gaging stations. However, because few gaging stations are located at sites subsequently selected for reservoirs, a streamflow inventory of a region, suitable for use in reservoir design, must include information which will permit development of draft-storage relations anywhere in the region. Draft-storage characteristics can be related to the within-year variability of streamflow and to the mean and variability of annual mean flows. Such relations defined from gaging station records, can be applied to other sites at which the variables in the relation can be estimated. Within-year variation can be represented by the median annual low flow which can be estimated from a few base flow measurements. Methods are given for estimating the mean and variability of annual mean flow from both humid and semi-arid basins. Examples of each of the methods described above show that the results are adequately reliable for design bases. A suitable data-collection network would consist of stream gaging stations, base flow discharge measurements at many sites, sediment and chemical-quality sampling stations, and climatological stations. (Knapp-USGS)
W70-05026

7B. Data Acquisition

USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,
Norges Tekniske Hoegskole, Trondheim. Dept. of Port and Ocean Engineering.
P. Bruun.
Engineering Geology, Vol 4, No 1, p 73-88, January 1970. 16 p, 24 fig, 1 tab, 33 ref.

Descriptors: *Tracers, *Tracking techniques, Radioactivity techniques, Bibliographies, Dye releases, Sediment transport, Tagging, Analytical techniques, Fluorescence, Marking techniques, Flow, Hydraulics.
Identifiers: Tracer techniques.

The uses of tracers in ocean, harbor, coastal, and river engineering are described. Some applications of tracers in pollution control are described in detail. Tracers and analytical techniques used in studying drift patterns and flow rates are listed. A bibliography of theoretical and practical references is included. (Knapp-USGS)
W70-04551

DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
Missouri Univ., Kansas City. Dept. of Chemistry.
Donald W. Dickey, James H. Wiersma, Russell G. Barnekow, Jr., and Peter F. Lott.
German summary included. Mikrochimica Acta, Vol 3, p 605-610, 1969. 6 p, 1 tab, 8 ref. OWRR Proj No A-009-MO, NIH Grant GM 12830-02.

Descriptors: *Chemical analysis, *Trace elements, Geochemistry, Water chemistry, Water analysis, Toxicity, Water pollution effects, Soil contamination effects.
Identifiers: *Selenium.

A simple semi-quantitative fluorometric method for selenium analysis has been developed which employs the reagent 2,3-diaminonaphthalene and the ring oven technique. By this procedure selenium can be determined to 10 ppb; the optimum working range is 20-80 ppb. The concentration of selenium is ascertained by visual observation of the rings under long wavelength UV light. (Knapp-USGS)
W70-04561

SENSOR DETECTION CAPABILITIES STUDY,
Geological Survey, Washington, D.C.
John E. Wilson.
Report available free on application to the U S Geological Survey, Washington, D C 20242. Geological Survey Circular 616, 1969. 26 p, 7 fig, 1 tab, 25 ref. NASA Contract No W-12570, task No 160-75-01-31-10.

Descriptors: *Remote sensing, *Aerial photography, *Radar, *Exploration, Surveys, Investigations, Water resources, Research and development, Evaluation, Resource development, Resources, Natural resources, Water resources.
Identifiers: Remote sensor capabilities.

Ten sensors used in collecting data for earth resources studies were investigated and rated. Four major variables which affect the selection of an appropriate sensor are: (1) Target and background identity; (2) Sensor availability; (3) Sensor capabilities and characteristics; and (4) Data collection system economics. Sensor records that were viewed and rated included: (1) Black and white photography; (2) Color photography; (3) Infrared (IR) color photography; (4) Black and white infrared photography; (5) 2- to 4-micron thermal infrared imagery; (6) 8- to 14-micron thermal infrared imagery; (7) Side-looking radar (SLAR) imagery; (8) Electro-optical (television) imagery; (9) Imaging microwave imagery; and (10) Nonimaging scatterometer data. Of the 98 targets considered in this evaluation, 89 indicated that a photographic system held the greatest promise of object detection. Infrared, side-looking radar, scatterometer, and passive microwave each were capable of significant contributions over one or more of the listed targets. (Knapp-USGS)
W70-04592

HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
Geological Survey, Denver, Colo.
For primary bibliographic entry see Field 02F.
W70-04598

RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
For primary bibliographic entry see Field 08F.
W70-04620

RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
Institute for Building Technics, Warsaw (Poland).
For primary bibliographic entry see Field 08F.
W70-04621

SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
Detroit Edison Co., Mich.
For primary bibliographic entry see Field 08C.
W70-04622

THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
Union Carbide Corp., Oak Ridge, Tenn.
For primary bibliographic entry see Field 08G.
W70-04624

AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
Wisconsin Univ., Madison.
For primary bibliographic entry see Field 08D.
W70-04630

MEASURING MOISTURE WITH GAMMA RADIATION,
For primary bibliographic entry see Field 08G.
W70-04641

DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPINS PLANT, COLORADO-BIG THOMPSON PROJECT,
Bureau of Reclamation, Denver, Colo.
For primary bibliographic entry see Field 08C.
W70-04645

A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
Centre Universitaire Marseille-Luminy, Marseille (France). Geology Lab.
For primary bibliographic entry see Field 02J.
W70-04731

AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
Wisconsin Univ., Madison. Water Chemistry Lab.
G. Fred Lee.
Proceedings of International Biological Program Symposium Held in Amsterdam and Nieuwersluis, Netherlands, October 10-16, 1966. Chemical Environment in the Aquatic Habitat, G L Golterman and R S Clymo, editors, N V Noord-Hollandsche Uitgevers Maatschappij, Amsterdam, 1967. p 169-180. 2 fig, 1 tab, 32 ref, Comment.

Descriptors: *Chemical analysis, *Water chemistry, *Instrumentation, Alkylbenzene sulfonates, Colorimetry, Volumetric analysis, Limnology, Monitoring, Water pollution, Water quality, Phosphates, Chlorides, Bicarbonates, Carbonates, Hydrogen ion concentration, Calcium, Magnesium, Chemical oxygen demand, Dissolved oxygen, Sulfates, Organic acids, Flame photometry, Fluorometry, Nutrients, Vitamins, Enzymes.
Identifiers: *Automated methods, Data acquisition, Electrometric methods, Technicon AutoAnalyzer, Fisher Scientific Automatic Titrator, Coulometry, Conductometry, Atomic absorption spectroscopy.

Water pollution monitoring and limnochemical research programs often require chemical analyses of large numbers of samples. Automated procedures for colorimetry and electrometry have been used and offer even greater promise for the future. In a typical colorimetric application, the Technicon AutoAnalyzer, key development of which is a reliable proportionating pump, assemblages of various modules make possible analyses involving diverse manipulations including distillation, solvent extraction, dialysis, and precipitation. Possibility of replacing colorimeter with other detectors (flame photometer, atomic adsorption spectrophotometer, continuous flow fluorometer) insures greater flexibility. A table of 40 water analyses which have been automated includes procedures diverse as alkyl benzene sulfonates, chemical oxygen demand, plant nutrients, and various vitamins and enzymes. Example of an automated phosphate analysis is described in detail. Automated procedures may permit greater precision, and, due to careful control of conditions at each step, may allow use of reactions which do not proceed to completion. Automatic and semi-automatic titrations are also effective. The paper describes a European example of titrimetry which permits nine separate analyses. Future developments in automation will include self-contained monitoring stations for collection of limnological data. A list of American equipment manufactures is included. (See W70-04821). (Eichhorn-Wisconsin)
W70-04822

DETERMINATION OF VITAMINS IN SEA-WATER,
California Univ., San Diego, La Jolla. Inst. of Marine Resources.
A. F. Carlucci, and S. B. Silbernagel.
Proceedings of International Biological Program Symposium held in Amsterdam and Nieuwersluis, Netherlands, October 10-16, 1966. Chemical Environment in the Aquatic Habitat, Golterman, H L and Clymo, R S, editors, N V Noord-Hollandsche Uitgevers Maatschappij, Amsterdam, 1967, p 239-244. 2 tab, 12 ref.

Descriptors: *Vitamins, *Bioassays, *Sea water, Organic matter, Carbon radioisotopes, Algae, Physiological ecology, Water pollution effects, Diatoms, Yeasts, Dinoflagellates, Aquatic bacteria, Oceanography, Pacific Ocean, Biomass, Zooplankton, Chlorophyll, Bioindicators.
Identifiers: *Organic solutes, Vitamin B-12, Thiamine, Biotin, Radiocarbon uptake techniques, Algal enumeration, Microbial ecology, Data acquisition, Cyclotella nana, Gyrodinium cohni, Phycomycetes, Isolate S-3, Cryptococcus albidus, Monochrysis lutheri, Amphidinium carteri.

A variety of microorganisms have been used in bioassays for minute concentrations of ecologically important vitamins (B-12, biotin, thiamine) dissolved in the hydrosphere. Assay procedures are outlined for seawater in which radiocarbon uptake or cell numbers can be evaluated after incubation of organisms in nutrient-enriched media under carefully controlled conditions. Both internal standards, to assess seawater toxicity, and external standards, to establish a calibration curve, are utilized. Organisms employed in the assays (with effective assay ranges, in nanograms/liter, indicated in parentheses) are: B-12--Cyclotella nana (0.05-3); thiamine--Monochrysis lutheri (2-35); biotin--Amphidinium carteri (0.2-5). Data derived from such bioassays are reported for stations of the North Pacific Ocean along a transect from Kodiak, Alaska, to Honolulu, Hawaii. Ranges of concentrations (in nanograms/liter) reported are: B-12, undetectable-0.88; thiamine, 3.4-32.0; biotin, 1.0-3.0. Concentrations of vitamin B-12 are apparently inversely correlated with biomass of chlorophyll and zooplankton. Microbiological assays described here detect concentrations considerably lower than do methods described previously, and they are sensitive in ecologically important ranges. (See W70-04821). (Eichhorn-Wisconsin)
W70-04823

7C. Evaluation, Processing and Publication

RESOURCE CONSERVATION GLOSSARY,
For primary bibliographic entry see Field 10.
W70-04559

ACCURACY OF STREAMFLOW CHARACTERISTICS,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 02E.
W70-04564

MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 04C.
W70-04575

VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
System Development Corp., Santa Monica, Calif.

System Development Corporation Technical Memorandum TM-4023/006/00, July 31, 1969. 216 p, 11 fig, 58 tab, append. ONR Contract No N00014-67-C-0559.

Descriptors: *Data storage and retrieval, *Data processing, *Information retrieval, *Oceanography, Documentation, Management, Planning, Methodology, Project planning, Systems analysis, Technology, Marine geology.
Identifiers: Data systems, Data management.

The objective of the Technical Development Plan (TDP) is to improve marine data products and services provided by the Federal Government to a variety of users. The TDP recommends that products and services be improved both by enhancing existing products and services and by introducing new products and services. Recommendations are also made for increases in data acquisition, improvements in existing data bases and the development of new data bases. The mechanisms chosen for achieving greater benefits for users are (1) the upgrading of Federal agency data service and product operations and (2) the improvement of the marine data network for the collection, transmission, storage and dissemination of marine data. A 10-year, time-phased plan was designed to provide the resources necessary to achieve the improvements. The TDP includes provisions for new instrumentation and new data communication and processing hardware, hardware costs, software development and maintenance, software personnel and costs, computer operations personnel and costs, and application and discipline personnel and costs. (Knapp-USGS)
W70-04600

AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
Bureau of Sport Fisheries and Wildlife, Amherst, Mass.
James A. McCann.
Water Resources Research Center, University of Massachusetts, Amherst, Publication 10-1, Dec, 1969. 102 p, 119 maps, 17 ref. OWRR Project A-999-MASS.

Descriptors: *Data collections, *Surveys, *Land use, *Water utilization, Fishing, Recreation, Water quality, *Massachusetts, Limnology.
Identifiers: *Cape Cod.

This is an inventory of the physical, biological and land-water use characteristics of all ponds, lakes, and reservoirs over five acres or identified on U.S. Geological topographic maps of Barnstable County, Massachusetts. Data from published sources or from official files of federal, state and regional water resources agencies were summarized, recorded on standard forms, coded, and keypunched on automatic data processing cards. The physical characteristics of the ponds were updated to include all standing bodies of water over five acres located on serial photographs taken in the spring of 1965.
W70-04651

A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
Rutgers - The State Univ., New Brunswick, N.J. Dept. of Meteorology.
For primary bibliographic entry see Field 02B.
W70-04718

ANALYSIS OF WATERSHED CHANGES,
Hydrocomp International, Palo Alto, Calif.
Norman H. Crawford.
In: Effects of Watershed Changes on Streamflow Water Resources Symposium No 2, Austin, Texas, October 1968, p 27-34, University of Texas Press, Austin and London, 1969. 8 p, 4 fig, 2 tab, 6 ref.

Descriptors: *Model studies, *Simulation analysis, *Rainfall-runoff relationships, Urbanization, Computer models, Mathematical models, Statistical models, Routing, Runoff, Streamflow forecasting, Probability, Systems analysis.
Identifiers: Watershed models, Watershed changes.

Watershed changes can be classified by purpose as altering runoff volumes, flow duration characteristics, or floodflows. Changes in runoff volumes and changes in flow duration characteristics require land surface changes. Land surface changes occur in agricultural activitics, in forest fires, and in urbanization. In general, the hydrologic effect of

land surface change is only one of many considerations. Deliberate land surface changes are seldom carried out for hydrologic benefits only; where farming practices are changed, agricultural as well as hydrologic benefits are sought. Hydrologic damages are seldom sufficient to prevent planned land surface activities. Digital computer hydrologic simulation is particularly helpful in interpreting land surface changes. Flows can be simulated before and after a change to find the effect of the change on infiltration rate and soil moisture storage. Channel system changes are well suited to analysis with current programming techniques. Interaction between land surface runoff sequences and channel network response can be easily studied for scores of combinations of physical works. This is most helpful in tracing physical interactions between several projects in a watershed. (See W70-04723). (Knapp-USGS)
W70-04728

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
Research Inst. for Water Resources Development, Budapest (Hungary).
For primary bibliographic entry see Field 02H.
W70-04757

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
North Carolina Univ., Chapel Hill.
For primary bibliographic entry see Field 06A.
W70-04986

08. ENGINEERING WORKS

8A. Structures

JUDGMENT FACTORS IN INSPECTION OF DAMS,
Harza Engineering Co., Chicago, Ill.
Andrew Eberhardt.
Water Power, Vol 21, No 11, p 431-435, Nov, 1969. 5 p, 4 ref.

Descriptors: Decision making, *Inspection, *Dams, Earth dams, Concrete dams, Dam foundations, Spillway design flood, Design flood, Design data, *Safety, Safety factors, Risks, Hazards, Responsibilities, Operation and maintenance, Performance, Exploration, Investigations, Rehabilitation, Reliability.
Identifiers: *Engineering evaluation, Remedial treatment, Spillway capacity, Flood estimate.

Good engineering judgment is essential in designing dams, and may be more important in making decisions about the competency of existing dams. Several cases are cited, pointing out some problems and judgment factors involved in evaluating competency of existing dams. Problems discussed are: (1) lack of and unreliability of data about investigation, design, construction, and performance; (2) misleading appearances; (3) poor and incorrect operation and maintenance; (4) owners' uncooperation and judgments based on past successful performance; (5) design shortcomings; and (6) lack of money for investiations and remedial measures. Judgment-type decisions about dams require weighing against each other elements of safety, risk, cost, practical limitations, and possible damages. Every dam that impounds water presents a potential danger that should be neither underestimated nor overestimated; risk of sudden disaster is forever inescapable. There are challenges to accept, responsibilities to bear, and consequences to face in inspecting and designing dams. (USBR)
W70-04617

MECHANICAL STRUCTURES FOR FARM IRRIGATION,
Agricultural Research Service, Kimberly, Idaho. Snake River Conservation Research Center.
For primary bibliographic entry see Field 03F.
W70-04638

STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
Lockheed-Georgia Co., Marietta.
William F. Bates, Jr., and William M. Cox.
Proc Amer Soc Civ Eng, J Struct Div, Vol 95, No ST11, p 2433-2448, Nov 1969. 16 p, 16 fig, 2 ref, 2 append.

Descriptors: *Computer models, *Computer programs, *Structural analysis, *Graphical analysis, Computers, Computer systems components, Structural design, Analysis, Data processing, Structural engineering, Structural models.
Identifiers: Computer-aided design, Computer capability, Man-machine systems, Matrix methods (Structural).

The emerging uses of computer graphics in structural engineering and design, especially in transferring numerical output into visual graphical form, are discussed. A 2-dimensional structure analysis program developed for a computer system at Lockheed-Georgia Laboratory is described. Civil engineering is a prime field for implementing computer graphics to reduce calculation time and quantity of input. Future expansion of computer graphics in engineering is described. Uses being developed include some that will display 3-dimensional structural arrangements and permit broader man-machine interaction in input and output phases. Also under development is the kinematic analysis of 3-dimensional mechanisms to optimize space requirements and maintain clearance. Computer graphics points the way toward better man-machine communication in all phases of design. (USBR)
W70-04643

SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
Geological Survey, Washington, D.C.
Arthur H. Lachenbruch.
Report available free on application to the US Geological Survey, Washington, DC 20242. Geological Survey Circular 632, 1970. 23 p 6 fig, 8 tab.

Descriptors: *Permafrost, *Melting, *Pipelines, *Alaska, Frozen ground, Frost heaving, Mud, Ice, Soil mechanics, Tundra, Engineering geology, Ecology.
Identifiers: Pipeline design, Permafrost engineering.

As one means of transporting crude oil from oil fields on the Alaskan Arctic coast to a year-round ice-free port, a large pipeline traversing most of the state of Alaska from north to south has been proposed. Plans call for a pipe 4 feet in diameter, which will be buried along most of the route in permafrost. The initial heat in the oil plus frictional heating in the pipe are expected to maintain oil temperatures in the neighborhood of 70 deg to 80 deg C (158 deg to 176 deg F). Such an installation would thaw the surrounding permafrost. Where the ice content of permafrost is not high, thawing by the buried pipe might cause no special problems. Under adverse local conditions, however, this thawing could have significant effects on the environment, and possibly upon the security of the pipeline. In this report a few basic principles are applied to simplified models of permafrost regimes to identify some effects of a heated pipe, the conditions that control them, and the approximate ranges of physical properties for which these effects are likely to result in problems. (Knapp-USGS)
W70-04694

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
Transdanubian water Authority, Szekesfehervar (Hungary).
For primary bibliographic entry see Field 04A.
W70-04747

CONTROL OF SULFATE-REDUCING BACTERIA,
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Microbiology Section.
For primary bibliographic entry see Field 05G.
W70-04813

RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
Missouri Univ., Columbia.
James W. Baldwin, Jr.
Report, University of Missouri, Columbia, Civil Engineering Dept, 1969. 22 p, 8 fig, 2 ref.

Descriptors: Shear strength, Shear forces, *Beams (Structural), Moment distribution, Compressive strength, Structural steel, Concretes, Stress analysis, Structural members, Structural engineering, Structural design, *Structural analysis, Analysis.
Identifiers: *Ultimate strength design, *Ultimate strength, *Composite beams, Hybrid beams, Shear connectors.

The moment capacity of a composite beam varies along the length of the beam, and the ultimate strength is not necessarily governed by the section at which maximum moment occurs. An ultimate strength analysis that allows computing ultimate moment capacity at any section of a concrete on steel composite beam is presented. The analysis can be applied to beams having partial length cover plates, unsymmetrical sections, hybrid sections, or any combination of these features. Computations for complete moment capacity diagrams are lengthy, but for design purposes, computations need be made only for sections likely to be critical. Generally, sections of maximum moment, sections at concentrated loads, and sections at abrupt changes in geometry should be investigated. Indiscriminately using uniform spacing of shear connectors may lead to unconservative design.
W70-04893

. . . THE ROMAN DAMS OF SUBIACO,
Imperial Coll. of Science and Technology, London (England).
Norman A. F. Smith.
Technology and Culture, Vol. 11, No. 1, p58-68, January 1970.

Descriptors: *Reservoirs, *Dam design, *Dam failure, Damsites, Recreation, Water supply, History.
Identifiers: Italy, Roman Empire.

In the Aniene valley above Subiaco, Italy, are the sites of three dams, constructed during the first century A.D., which are of great interest for three reasons: first, they were built primarily for recreational purposes related to the nearby villa of Nero; second, they were, as far as is known, the only dams which the Romans built in their own country; and third, one of them, was probably the highest dam, about 130 feet, in the Roman Empire and perhaps in the world until the Alicante dam, in Spain, of 1594. The dams apparently continued in use up to medieval times. The largest dam did not collapse until 1305, according to contemporary records, when two monks took stones from the dam in an attempt to lower the level of the impounded water which was flooding their lands. This articles discusses the probable damsites, remains, construction, and use in relation to ancient sources, a previous 19th century investigation, and a painting of 1428 in the monastery of Saint Benedict which seems to depict the saint fishing from the crest of the dam. A drawing based upon this painting is a part of the article and is also used as the front cover design for this issue of Technology and Culture. (Cowgill-OWRR)
W70-04980

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
Zuider Zee Works (Netherlands). Hydrology Section.
C. H. De Jong.

French resume included. In: Hydrology of Lakes and Reservoirs, Symposium of Garda (Oct 9-15, 1966), International Association of Scientific Hydrology, Publication No 71, p 565-574, 1966. 10 p, 3 fig, 1 ref.

Descriptors: *Reservoirs, *Multiple-purpose reservoirs, *Drainage, *Water storage, *Land reclamation, Land management, Water levels, Water-level fluctuations, Canals, Pumping, Evaporation, Inflow, Hydrologic budget, Streamflow forecasting, Water quality.
Identifiers: *Netherlands, IJssel Lake, Polders.

The IJssel Lake is an important part of the Zuiderzee project, which is being carried out in the Netherlands to extend the land area by reclamation and to improve the water management of a large area around the lake. The lake has to satisfy various interests such as drainage of and water supply to surrounding areas, navigation, fishing, and recreation, each with its own demands with regard to the management of the lake. Since some of the adjacent areas have a ground level almost 5 m lower than mean sea level and are densely populated with increasing industrialization, inundation has to be prevented even under extreme circumstances of heavy storms and high water levels on the lake. The efficiency of the water management of the lake is judged by the level of the lake, the available amounts of water during droughts and the quality of the water. The variations of these factors depend on the size, normal level, and dimensions of the discharge sluices. They are interrelated via the equations of continuity for the water and the salt in the lake. The methods for the design of the lake are discussed. (Knapp-USGS)
W70-05027

8B. Hydraulics

VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
Imperial Coll. of Science and Techology, London (England).
For primary bibliographic entry see Field 02E.
W70-04553

A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Civil Engineering.
For primary bibliographic entry see Field 02A.
W70-04563

RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
Geological Survey, Menlo Park, Calif.
For primary bibliographic entry see Field 02E.
W70-04565

MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
Chevron Oil Field Research Co.
L. W. Thrasher, and P. M. Aagaard.
Journal of Petroleum Technology, p 339-346, March 1970. 8 p, 9 fig, 3 tab, 3 ref.

Descriptors: *Waves (Water), *Ocean waves, *Offshore platforms, *Hurricanes, *Energy, Hydrodynamics, Data collections, Hydraulics, Coastal engineering, Instrumentation.
Identifiers: Hurricane wave forces.

Wave forces on vertical cylinders and wave profiles were measured with instruments on two oil production platforms in 30 ft (1954-1958) and 100 ft (1960-1963) of water, respectively, in the Gulf of Mexico. Wave data were recorded during a number of storms and for waves up to 40 ft high. The purpose of the paper is to present the following background information that defines the wave force data being made available: (1) instrumentation, (2) raw data collected, (3) data processing steps, and (4) location of archives. (Knapp-USGS)
W70-04699

ANALYSIS OF WAVE FORCE DATA,
Shell Development Co., Houston, Tex.
D. J. Evans.
Journal of Petroleum Technology, p 347-358, March 1970. 12 p, 23 fig, 2 tab, 19 ref.

Descriptors: *Waves (Water), *Ocean waves, *Energy, Hurricanes, Hydrodynamics, Hydraulics, Offshore platforms, Coastal engineering.
Identifiers: Morison wave force equation, Stokes wave theory.

Wave profile and wave force data acquired in the Gulf of Mexico from several hurricanes have been analyzed to provide the drag and inertial coefficients of Morison's wave force equation. These coefficients are required to help determine design loads for offshore structures. An analysis, using nonlinear wave theories, of profile and force data from waves in shallow water gave drag and inertial force coefficients of 0.5 and 1.2, respectively. Data acquired in 100 ft of water gave a slightly larger drag coefficient (0.58) and a larger inertial coefficient (1.76). Good agreement between measured and predicted forces was observed. (Knapp-USGS)
W70-04700

METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
Esso Production Research Co., Houston, Tex.
J. D. Wheeler.
Journal of Petroleum Technology, p 359-367, March 1970. 9 p, 11 fig, 4 tab, 14 ref.

Descriptors: *Ocean waves, *Energy, *Hurricanes, *Offshore platforms, Waves (Water), Hydraulics, Hydrodynamics, Coastal engineering, Mathematical studies.
Identifiers: Wave force, Airy theory, Morison wave force equation.

A new method is described and evaluated for calculating wave forces on offshore structures. It is based on an extension of Airy theory for two-dimensional waves and uses a linear filtering technique to calculate wave forces as a function of time for wave profiles of arbitrary shape and length. It is especially useful for evaluating the forces exerted on offshore structures by a sequence of irregular storm waves. The accuracy of the method is checked by comparison with measured hurricane-wave forces. (Knapp-USGS)
W70-04701

WAVE FORCES: DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
Florida Univ., Tallahassee; and Chevron Oil Field Research Co.
R. G. Dean, and P. M. Aagaard.
Journal of Petroleum Technology, p 368-375, March 1970. 8 p, 11 fig, 2 tab, 17 ref.

Descriptors: *Waves (Water), *Ocean waves, *Energy, *Offshore platforms, Hydrodynamics, Hydraulics, Coastal engineering, Computer programs, Mathematical models, Unsteady flow.
Identifiers: Morison wave force equation.

A mthod for calculating ocean wave forces on offshore drilling structures is based upon (1) data from two full-scale wave force measurement installations in the ocean and (2) a mathematical model representing hydrodynamic forces on submerged bodies in unsteady flow and the kinematic flow field of highly nonlinear waves. The method is applicable to a broad range of wave conditions commonly encountered in offshore structure design. Several comparisons show that the method represents measured forces satisfactorily for engineering design. (Knapp-USGS)
W70-04702

RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.
R. Viskanta.
Advances in Heat Transfer, Vol. 3, p 175-251, Acad. Press, New York, London, 1966, 20 fig, 100 ref.

Descriptors: *Heat transfer, *Temperature, *Radiation, Microwaves, Conduction, Heating, Cooling, Thermal radiation, Laminar flow, Turbulent flow, Viscous flow, Fluid mechanics, Reynolds number, Boundary layers, Velocity, Momentum equations.

The purpose of the review is: (1) to develop general background information to analyze heat transfer in radiating media, and (2) to review the literature of some specific convection-radiation interaction problems. The radiation terms were included in the equations of continuity, motion, and energy, and an approximate solution was obtained for some flow patterns (Couette flow, laminar boundary layer flow, heat transfer to a radiating fluid flowing in a channel). The solution of the more complex equation is very time consuming even with the use of fast digital computers. (Novotny-Vanderbilt)
W70-05035

THE EFFECT OF FREE STREAM TURBULENCE ON HEAT TRANSFER RATES,
Brown Univ., Providence, R. I. Div. of Engineering.
J. Kestin.
Advances in Heat Transfer, Vol. 3, p. 1-32, Acad. Press, New York, London, 1966, 20 fig., 51 ref.

Descriptors: *Heat transfer, *Turbulence, Boundary layers, Turbulent boundary layers, Reynolds number, Heating, Cooling, Conduction, Convection, Heat flow, Temperature, Heat pollution, Flow around objects, Fluid mechanics.
Identifiers: Hydraulics of heat transfer.

The effect of free stream turbulence on the size of Nusselt's number, which characterizes heat flow, is discussed. Different methods of applying of the boundary layer theory are presented. The sound field which produces the harmonic oscillation can be used for studying of effects of oscillations on heat transfer instead of stochastic oscillations of the turbulence. An oscillating free stream velocity produces in a laminar boundary layer two main effects: (1) the velocity components u and v in the boundary layer themselves become time dependent, so that $u = u(x,y,t)$. (2) The oscillation inside of the boundary layer acquires a varying phase shift whose magnitude depends on the transverse coordinate y. Calculations showed that the skin friction coefficient on the plate boundary increases much less (by 5% for Pr approximately 0.7) than the Nusselt number (which increased by 26%) compared with the classical case of two-dimensional flow with zero vorticity in the approaching stream. It was found that the turbulence intensity expressed in % of (sq. root of u to the 12th power)/U has a small effect on the heat transfer coefficient in most cases. (Novotny-Vanderbilt)
W70-05036

HEAT AND MASS TRANSFER IN TURBULENT BOUNDARY LAYERS,
Akademiya Nauk SSSR, Novosibirsk.
A. I. Leonter.
Advances in Heat Transfer, Vol. 3, p. 33-100, Acad. Press, New York, London, 1966, 90 ref.

Descriptors: *Heat transfer, *Mass transfer, Boundary layer, Reynolds number, Films, Temperature, Turbulence, Convection, Conduction, Flow, Flow around objects, Heating, Cooling, Fluid mechanics.

The problem of heat exchange in flow with a high Reynolds number is discussed. Under these conditions, the relative thickness of the viscous sublayer tends to approach zero and the problem is reduced

to analyzing the influence of different disturbing factors as nonisothermality, mass transfer, longitudinal pressure gradient, etc. The theoretical base for the formulae developing was Prandtl's theory. It was found that in the compressible turbulent boundary layer on a flat impermeable plate, the effect of Reynolds number has little influence on the relative values of friction and heat transfer coefficients. The effect of a finite Reynolds number on the friction and heat transfer lows on a permeable plate is even smaller than that on impermeable plates. The mathematical presentation of theory developed in Russia is described. (Novotny-Vanderbilt)
W70-05037

ADVANCES IN FREE CONVECTION,
National Engineering Lab., East Kilbride (Scotland).
A. J. Ede.
Advances in Heat Transfer, Vol. 4, p. 1-64, Academic Press, New York, London, 1967, 111 ref.

Descriptors: *Convection, *Heat transfer, *Energy transfer, Turbulence, Turbulent boundary layer, Eddies, Reynolds number, Viscosity, Air circulation, Water circulation, Boundary processes, Conduction, Momentum transfer, Mixing, Cooling, Heating, Heat balance.
Identifiers: Theory of heat transfer.

Convection of heat in laminar and turbulent flow is discussed. Solution to the equations of continuity, motion and energy are used as a base for further theoretical development. The problem of cooling on a flat plate leads to the following general formula: Nu = f (Gr x Pr) to the 1/4 power, where Gr = Grashof number, Pr = Prandtl number and Nu = Nusselt number, all expressing the major heat flow parameters. Different solutions to this equation are discussed and comparison with experimental data are presented. Similar solutions were applied also to the solution of cooling (heating) in turbulent flow. It is generally assumed that the Grashof number or the Rayleigh number (Gr x Pr) serves as the criterion for stability in free heat convection and the Reynolds number for forced heat convection. Different solutions of the Nusselt number for turbulent flow expressing the flow of heat lead to the formula Nu = BGr (n), where the exponent n was found to be found to be 0.25 divided by 0.33 in most cases. (Novotny-Vanderbilt)
W70-05038

STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
Argonne National Lab., Ill.
L. B. Koppel, R. D. Patel, and J. T. Holmes.
AIChE Journal, Vol. 5, No. 5, September 1966, p. 941-955, 3 tab., 7 fig., 4 ref. AEC Contract W-31-109-eng-8.

Descriptors: *Surfaces, *Mixing, Turbulence, Heat transfer, Mass transfer, Diffusion, Conduction, Heating, Cooling, Thermal properties, Thermal pollution, Thermal conductivity, Temperature, Hydraulics, Turbulent flow, Statistical models, Monte Carlo method.

In Part 1, Average transport coefficients for different transport models are computed by using widely varying distributions of residence times of elements at the transporting surface. It is shown that, for typical transport models, the shapes of the residence time and age distributions have an insignificant effect on the average transport coefficient. Operational techniques for calculating average coefficients and for constructing delayed versions of age distributions are presented. Residence time distribution may be generated by the gamma form which offers the following advantages for representation of residence time distribution: (1) The residence times are defined over an interval from zero to infinity, (2) This distribution offers convenient operational properties for calculating the average transport coefficient. Computation of Nusselt numbers of heat transport in fluidized bed is presented. In Part II, methods are developed to estimate the mean residence time and the average transport coefficients of elements at a transporting surface from observations of only total elements counts, rather than from specific observations of individual elements. The accuracy of the methods is demonstrated in Monte Carlo simulated processes and experimentally at the wall of a gas-fluidized bed. (Novotny-Vanderbilt)
W70-05039

EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
Colorado Univ., Boulder.
C. F. Dewey, Jr., and J. E. Gross.
Advances in Heat Transfer, Vol. 4, p. 317-446, 1967. 14 fig.

Descriptors: *Boundary layer, Temperature, Convection, Mass transfer, *Heat transfer, Velocity, Reynolds number, Viscosity, Turbulence, *Laminar flow, Turbulent flow, Energy transfer, *Numerical analysis, Computers, Viscous flow.
Identifiers: Laminar boundary layer.

Comprehensive, systematic and accurate tables of solution to the laminar boundary-layer similarity equations were computed for a perfect homogeneous gas. Solutions are included to illustrate the effect of leading edge sweep, the mass transfer at the surface, pressure gradient, the boundary temperature, local external flow velocity, the Prandtl number, and the viscosity-temperature law of the fluid. The program for the numerical integration of the system of equations expressing the continuity, motion, and energy balance was written in FORTRAN for the IBM 7044. The system was treated as a two-point boundary value problem, and the Runge-Kutta method was employed for the numerical integration. (Novotny-Vanderbilt)
W70-05040

TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
R. A. Gowen, and J. W. Smith.
International Journal, Heat and Mass Transfer, Vol. 11, p 1657-1673, Pergamon Press, New York, London, 1968, 20 ref, 20 fig, 4 tab.

Descriptors: *Heat transfer, *Convection, Turbulence, Temperature, Momentum transfer, Turbulent flow, Thermal properties, Reynolds number, Air temperature, Water temperature, Velocity, Roughness.

Radial temperature profiles have been obtained in a 2-in I.D. rough tube of equivalent sand roughness equal to 0.05 for Prandtl numbers of 0.7, 5.9 and 14.3 over a Reynolds number range 10,000-50,000. Plots of t (+) against log y/R are linear as in the case of u (+) for rough and smooth tubes, but the slope depends on Prandtl number and inferentially on the roughness. The t (+) intercept at log y/R = 0 is strongly dependent on the Reynolds number, unlike u (+) in turbulent rough pipe flow. An expression for the relation between t (+) and log y/R is presented, but the dependence of the slope AR on roughness remains to be determined. The heat-transfer efficiency St/CF was less in rough tubes than smooth ones for all the fluids studied, but the relative difference becomes smaller at higher Prandtl number and in the turbulent transition region. Friction factors and heat-transfer coefficients have also been measured in seven different 1/2-in I.D. rough pipes of known surface geometry. Equivalent sand roughness ranged from 0.021 to .095 for the pipes studied. A semi-theoretical equation based on the temperature profiles obtained in the 2-in. pipe predicts the results of the present study and Nunner's air results adequately. It underestimates the water results of Dipprey. (Novotny-Vanderbilt)
W70-05041

FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
Minnesota Univ., Minneapolis. Heat Transfer Lab.
F. K. Tsou, E. M. Sparrow, and R. J. Goldstein.
International Journal Heat and Mass Transfer, Vol. 10, p. 219-235, 1967. 11 ref., 11 fig.

Descriptors: *Heat transfer, Boundary processes, Mass transfer, Turbulent flow, Laminar flow, Mixing, Reynolds number, Turbulent boundary layers, Viscosity, Energy transfer, Momentum transfer, Convection, Velocity, Friction, Viscous flow.
Identifiers: Laminar boundary layers.

A combined analytical and experimental study of the flow and temperature fields in the boundary layer on a continuous moving surface has been carried out. The investigation includes both laminar and turbulent flow conditions. The analytical solutions provide results for the boundary-layer velocity and temperature distributions and for the surface-friction and heat-transfer coefficients. Measurements of the laminar velocity field are in excellent agreement with the analytical predictions., thereby verifying that a mathematically describable boundary layer on a continuous moving surface is a physically realizable flow. Experimentally determined turbulent velocity profiles are also in very good accord with those of analysis. Similar agreement is found to exist for friction coefficients deduced from the data by application of the Clauser-plot technique. Temperature distribution measurements, carried out for the turbulent boundary layer, show satisfactory correspondence with analysis. (Novotny-Vanderbilt)
W70-05042

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
Minnesota Univ., Minneapolis. Heat Transfer Lab.
E. R. G. Eckert, W. E. Ibele, and R. J. Goldstein.
Int. Journal Heat and Mass Transfer, Vol. 11, p. 83-116, 1968. 591 ref.

Descriptors: *Heat transfer, *Energy transfer, *Mass transfer, Conduction, Convection, Boundary layers, Cooling, Heating, Heat balance, Diffusion, Radiation, Thermal pollution, Thermal radiation, Laminar flow, Turbulent flow, *Reviews.
Identifiers: Literature review.

The review is concerned with research in the field of heat transfer, the results of which have been published during 1966 or late in 1965. The review contains the papers published in the following areas of the research of heat transfer: conduction of heat, channel flow, boundary layer flow, flow with separated regions, transfer mechanisms, natural convection, convection with rotating surfaces, combined heat and mass transfer, change of phase, radiation, liquid metals, low-density heat transfer, non-Newtonian fluids, measurement techniques, heat exchangers, aircraft and space vehicles, thermodynamic and transport properties. (Novotny-Vanderbilt)
W70-05043

8C. Hydraulic Machinery

SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
Detroit Edison Co., Mich.
R. B. Freydl, and B. D. Miller.
Transm Distrib, Vol 21, No 11, p 37-41, Nov, 1969. 5 p, 7 fig, 2 tab, 2 ref.

Descriptors: Costs, Instrumentation, X-ray inspection, Field tests, Laboratory tests, *Ultrasonics, Electronic equipment, Defects, *Sound waves, Wood, Inspection, Transmission lines, Power operation and maintenance.
Identifiers: *Sonic-pulse test, Sonic probes, *Wood-pole transm lines, Cost savings, Ultrasonic tests, Test results.

A sonic test instrument developed for determining defects in wood poles is fast, reliable, and economical. Results of the testing technique on nearly 300,000 poles during the past 3 yr have been successful and the per-pole cost of inspection has been reduced substantially. The sonic testing device is a 5-lb, portable, transistorized meter that evaluates the time required for a sound pulse to travel from one side of a pole to the other. Longer than normal travel time indicates decay or defect. The probes normally can be pushed through the earth against the pole without digging to test below the ground surface. Only poles showing defects must be checked by the X-ray method. The sonic test is fail-safe, showing pole characteristics other than pole life or strength. (USBR)
W70-04622

EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
Bureau of Reclamation, Denver, Colo.
F. R. Schleif.
Bur Reclam Lab Rep EP-32, Aug, 1969. 41 p, 10 fig, 3 tab, 20 oscillograms, 4 ref.

Descriptors: *Electric power, Model studies, *Control systems, Faults (Electrical), Voltage regulators, Governors, *Stabilization, *Damping, Transmission (Electrical), Electric generators, *Excitation, Model tests.
Identifiers: Electrical system simulators, *Excitation regulators, Power system stability.

Performance tests of supplementary excitation control apparatus for system damping, conducted on the Edison Electric Institute model system in cooperation with the AC/DC System Operation Research Project, have been very revealing. Flexibility of the model permitted evaluation under a range of conditions not conveniently obtainable on one power system. Evaluations included: (1) influence of local resistive and induction motor loads, (2) performance during system faults, (3) signal cutoff vs signal limit-type constraints, and (4) performance on a-c and on a-c and d-c transmission systems with and without modulation of the latter for damping. Effectiveness and compatibility were good. The mechanism of damping, characteristics, and applicability are discussed. (USBR)
W70-04623

DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
Brown, Boveri and Co. Ltd., Baden (Switzerland).
G. Maier, and H. J. Vorwerk.
Brown Boveri Rev, Vol 56, No 5, p. 246-255, May 1969. 10 p, 14 fig, 1 tab, 5 ref.

Descriptors: *Dielectrics, *Electric insulation, *Direct current, Transformer oils, Impulse tests (Electrical), Electric potential, Power transformers, Electric reactors, Converters (Electrical), Transmission lines, Foreign research, Electrical equipment, Electrical insulators, Stress, Alternating current, Polarity.
Identifiers: *Electrical insulation tests, *High voltage, Dielectric properties, Test results, Withstand level (Electric), Switzerland.

Converter transformers, smoothing reactors, and auxiliary power apparatus used in hvdc transmission systems have insulation similar to that in a-c voltage equipment. The primary insulating materials are oil, oil-impregnated paper, transformer board, and in certain cases bakelized synthetic resin-bonded paper. The materials in hvdc systems are under different stresses than materials in a-c applications. In one instance, the dielectric voltage distribution obeys different laws, and in the other, the breakdown phenomena and dielectric properties are different compared to the a-c voltage conditions. These particular features must be taken into consideration when designing hvdc systems, assuming that new problems are known and that adequate experience has been gained regarding the behavior of the insulating materials under given conditions. Simple models were used to perform tests on the main insulating materials including oil, oil-impregnated paper, and transformer board using specific voltages similar to those occurring in the converter transformers and smoothing reactors in hvdc stations. Various guides were derived from the measured results, indicating the aptness of some voltage tests on finished equipment. (USBR)
W70-04640

DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
Chubu Electric Power CO. (Japan).
H. Terase, K. Sadamoto, and K. Abe.
Elec Eng Japan, Vol 89, No 2, p. 29-38, 1969. 10 p, 8 fig, 1 tab, 5 ref.

Descriptors: *Dielectrics, *Faults (Electrical), *Transmission lines, *Electrical insulators, Electric currents, Extra high voltage, Electric insulation, Experimental data, Electric arcs, Electric potential, Recovery, Photographs, Foreigh research, Characteristics, Electrodes, Time.
Identifiers: *Dielectric properties, Ionization potentials, Japan, *Suspension insulators, Photographic analysis, Test results.

The study of dielectric strength recovery characteristics after fault arc extinction is important in determining the no-voltage time of a high-speed, 3-phase, reclosing system. Few papers have discussed the problem, and few experimental studies have been reported. Large fault current interruption is discussed. The dielectric strength recovery characteristics of suspension insulators and V- and dead-end strings in 500-kv transmission lines were studied by applying a probing voltage of slow wavefront to the insulators at about 5 cycles after the interruption of a fault arc current of 8 ka. Results from the high-speed camera photograph show that the behavior of a luminous gas cloud emerging from arcing horns is related closely to the recovery characteristics. (USBR)
W70-04642

DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPINS PLANT, COLORADO-BIG THOMPSON PROJECT,
Bureau of Reclamation, Denver, Colo.
J. C. Shuster, and R. L. Hansen.
TID-25185, U S Atom Energy Comm, Contract AT (49-11)-2758, July 1969. 41 p, 28 fig, 15 tab, 1 ref, addend.

Descriptors: *Water measurements, *Radioisotopes, *Tracers, *Discharge measurements, Hydraulics, Physics, Fluorometry, Penstocks, Field tests, Pump turbines, Water sampling, Turbines, Injectors, Pipelines, Radioactivity techniques, Colorado.
Identifiers: *Velocity method, *Total count method, *Dilution method, Flatiron Powerplant, Colo, Atomic Energy Commission.

Radioisotopes techniques and equipment are being developed to improve methods for measuring flow rate in high-head turbines and pumps. A series of discharge measurements was made in 1968, at Flatiron Power and Pumping Plant near Loveland, Colo, to evaluate techniques and equipment. Measurements were made on a 6000-ft-long, 6-ft-dia penstock at a discharge of 300 cfs. Thirty-seven injections of radioactive Brominc-82 were made for discharge measurements by the velocity method, 17 for the integrated-sample method, and 8 for the dilution method. The injections enabled computation of 33 discharges by the velocity method, 26 by the integrated sample method, 45 by the dilution method, and 34 by the total-count method. A 4-point injection system, 45 deg from the vertical and horizontal centerlines of the pipe, was used for most measurements. Mixing lengths ranged from 36 to 919 pipe diameters. Mixing lengths of 100 pipe diameters produced the same order the accuracy as mixing lengths of 919 diameters. Studies are continuing to increase measurement accuracy using pipe lengths as short as 30 pipe diameters. (USBR)
W70-04645

30 YEARS OF MAINTENANCE EXPERIENCE WITH LARGE KAPLAN TURBINES,
Corps of Engineers, Bonneville, Oreg.
Edward E. Ashley.
Amer Soc Mech Eng Publ, 69-WA/FE-17, Nov 1969. 8 p, 16 fig, 1 tab.

Descriptors: *Kaplan turbines, *Maintenance, Failure (Mechanics), Turbine parts, Thrust bearings, Hydroelectric plants, Turbine blades, *Bonneville Dam, Power operation and maintenance, Corrosion, Lubrication, Repairing, Contamination, Turbines, Costs.
Identifiers: Wicket gates, Packings.

Major problems encountered during 30 yr of operating large Kaplan turbines at the Bonneville Project are described. A few problems have been solved; others are being reviewed. The problem area includes theturbine and equipment associated with the turbine. Problems have involved: (1) grease line failure to the wicket gate lower bearing, failure of the wicket gate combination thrust and guide bearing, failure of the wicket gate stop block, and failure of a turbine guide bearing; (2) replacement of head cover sump pumps; and (3) maintenance of the turbine shaft packing box, turbine hub, wicket gate servomotor packing, Kaplan turbine blades, and oil head. Each problem is discussed and methods used in solving the difficulty are given. (USBR)
W70-04646

DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
Catalytic Construction Co., Philadelphia, Pa.
W. Pechenick, and C. E. Ennis.
Preprint SM-113/31 of Paper Presented at IAEA Symp. Nucl. Desalination, Madrid, Spain, Nov. 18-22, 1968. 8 p, 8 ref.
Identifiers: *Dual-purpose plant economics, Dual-purpose plant, Multiple effect distillation, Multistage flash distillation, Scale prevention, Single-purpose plant, Single-purpose plant economics, Steam cycle, Turbines, Vapor compression evaporation.

Distillation plants may use high pressure steam (above 150 psig) in one of two ways - as a source of mechanical energy in vapor compression or as a source of thermal energy directly in high temperature plants. High temperature operation has been made possible by development of the Mems plant and by development of improved scale control processes making 350 deg F operation feasible. Increasing the pressure range over which plants can utilize steam broadens the economic scope of desalting. Single-purpose plants, typified by a VC design can prove economical over a broader range of capacities and cost parameters. Dual-purpose plants may now be designed over a greater range of water-to-power ratios than was possible at lower pressures.
W70-04670

RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
Aqua-Chem, Inc., Waukesha, Wis.
For primary bibliographic entry see Field 03A.
W70-04671

LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
Bureau of Reclamation, Denver, Colo.
Ernest H. Johnson.
Pap 69-WA/FE-31, Amer Soc Mech Eng Publ, 1969. 8 p, 9 fig, 1 tab.

Descriptors: *Axial flow, *Propeller pumps, *Mixed flow pumps, *Pumps, Mechanical equipment, *Models, *Model tests, Design, Cavitation, Pump bowls, Vibrations, Efficiencies, *Hydraulic design, Instrumentation, Discharges, Specifications, Pump testing, Performance tests.
Identifiers: *Snake Creek Pumping Plant (N Dak), *Test results, High head, Garrison Diversion Unit (MRBP), Low head.

The large 685-cfs, 200-rpm, vertical-column main pumps to be installed by the Bureau of Reclamation at Snake Creek Pumping Plant No. 1, Garrison Diversion Unit, Missouri River Basin Project, N Dak, are described. Each pump has interchangeable axial- and mixed-flow bowl assemblies covering a head range of 2 to 76 ft. This arrangement combines 2 types of pumps into one. The wide head range resulted in a selection of 2 to 35 ft for the low-head, axial-flow bowl assembly, and 35 to 76 ft for the high-head bowl assembly. The time between bowl assembly interchange will depend upon runoff and reservoir storage conditions and will occur at intervals varying from 2 to 9 yr. The interchange operation will require about 2 days per pump. Model tests indicate an excellent design meeting or exceeding all requirements of the specifications. Model operation was smooth and quiet without apparent cavitation throughout the normal operating head range of each bowl assembly; no excessive vibration occurred from minimum to shutoff head. (USBR)
W70-04894

8D. Soil Mechanics

AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
Wisconsin Univ., Madison.
Ralph W. Kiefer.
Proc Amer Soc Civ Eng, J Surv Mapp Div, Vol 95, No SU1, p 49-70, Oct 1969. 22 p, 16 fig, 32 ref, append.

Descriptors: *Aerial photography, *Photogrammetry, *Flood plains, *Soil surveys, Soil formation, Flood plain zoning, Land use, Mapping, Remote sensing, Soils, Soil types, Terrain analysis, Planning, Photography, Project planning, Radar, Soil classifications, Soil investigations, Soil texture, *Soil surveys, Bibliographies, Geological surveys, Sensors.
Identifiers: *Aerial interpretation, *Photointerpretation, *Airborne surveying, *Flood plain studies, Soil deposits, Airborne equipment.

Urban planners and developers are giving increasing emphasis to the problems of land use on flood plains. To plan effectively for land use on flood plains, the distribution of soil types on the flood plain and the flood frequency must be known. The use of aerial photographic interpretation techniques for estimating flood plain soil conditions is described. New techniques of airborne remote sensing can also prove useful in flood plain soil studies. Imaging sensors such as infrared photography, color photography, infrared imagery, and side-looking airborne radar, as well as several nonimaging sensors, are described. To plan successfully for land use on flood plains, all available planning tools must be utilized. Much valuable information about flood plain soils can be obtained through aerial photographic interpretation studies. (USBR)
W70-04630

THE PHYSICS AND MECHANICS OF SOIL,
California Inst. of Tech., Pasadena.
Ronald F. Scott.
Contemp Phys, Vol 10, No 5, p 449-472, Sept 1969. 24 p, 18 fig, 8 ref.

Descriptors: *Soil formation, *Soil physics, *Soil mechanics, Soil analysis, Soil classifications, Soil compaction, Soil engineering, Soil groups, Soils, Soil properties, Flexible foundations, Earthworks, Reviews, Soil tests.
Identifiers: Soil characteristics, Soil development, Lunar soils.

The processes of soil formation, present knowledge of soil behavior, and techniques of soil engineering are reviewed. The origin of soil is in chemical processes of comminution and abrasion of rock masses and in physical processes of solution and recrystallization of rock minerals. After formation, soil is transported and distributed by a variety of agencies before subaerial or subaqueous deposition. Most soils experience several cycles of sedimentation, uplift, erosion, and redeposition. Mechanical behavior of soils under the stresses imposed by engineering structures varies with the type of soil. Deformation and failure of soils are of interest in designing structures, and must be studied by special laboratory tests. Solving soil engineering problems involves a field investigation and sampling program to define the boundaries of the soil involved, laboratory testing of the soil, and analytical or computer calculations to determine the displacements and stresses that will occur in the soil and structure. Problems of particular interest include: slope failures; design of earth dams, retaining walls, and piled structures; displacement and failure of soil under buildings, and determination of soil properties on the surface of the moon and other planets. (USBR)
W70-04631

EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
Oklahoma State Univ., Stillwater.
Frank C. Townsend, Phillip G. Manke, and James V. Parcher.
Highw Res Rec, No 284, p 76-84, 1969. 9 p, 2 fig, 3 tab, 17 ref.

Descriptors: *Laterites, *Residual soils, *Soil properties, Mechanical properties, Lime soil mixtures, Soils, Soil asphalt, Soil cement, Soil groups, Soil engineering, Soil formation, Soil strength, Soil mechanics, Soil tests, Soil physical properties, Soil stabilization, Soil structure, Bibliographies, Soil types, Test procedures.
Identifiers: Panama, Soil characteristics, Soil deposits, Soil development, Soil recompaction.

Engineering characteristics of a Panamanian lateritic soil were studied and the suitability of various stabilizing additives was investigated. Remolding by mechanical agents altered the physical properties and strength parameters of the soil. Grain size analysis and Atterberg limits tests show that remolding causes a breakdown of the granular structure and an increase in the plasticity of the soil. The efficacy of various stabilizing additives using worked and unworked soil samples was investigated. Stabilization is influenced by the amount of mechanical working. Portland cement was the most effective of the 3 additives tested and yielded higher unconfined compressive strengths with the unworked soil. Lime was also an effective stabilizer, but reacted more favorably with the soil in the worked condition. The primary benefit derived from asphaltic stabilization was waterproofing rather than substantial strength gains. A substantial portion of the clay particles was coated with iron and aluminum oxide (sesquioxide) films, and working by mechanical agents caused a breakdown of this coating allowing the clay particles to behave in a more characteristic fashion. (USBR)
W70-04632

A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
Clemson Univ., S.C.
Joseph P. Rostron, Arnold E. Schwartz, and Thomas E. Gioliosa.
Highw Res Rec, No 284, p 70-75, 1969. 6 O, 5 fig, 2 tab, 7 ref.

Descriptors: *Penetrometers, *Soil density, *Soil tests, Penetration resistance, Penetration tests, Soil moisture, Soil engineering, Soil mechanics, Soil properties, Calibrations, Compacted soils, Soil physical properties, Field tests, Fine-textured soils, Granular materials, Test procedures, Moisture content.
Identifiers: *Testing equipment, Accuracy, Construction control, Correlation.

The possible application of a drop hammer penetrometer to determine the density of soils was investigated. The penetrometer was designed to use a measured number of blows for a certain depth of penetration along with the use of a surcharge. For a given moisture content, a straight-line relationship was found between dry density and penetration resistance for the fine and granular materials tested. For field application of the drop hammer penetrometer, each soil must be calibrated for moisture sensitivity and penetration resistance characteristics. Because of possible thixotropic behavior, time lag between compaction and penetration readings should be kept to a minimum. The overall standard error of the procedure for all materials tested was 2.2 pcf. Total time required to determine the density of a calibrated soil using the penetrometer and the speedy moisture tester was approximately 15 min. (USBR)
W70-04633

PRESSUREMETER CORRELATION STUDY,
Louisiana Dept. of Highways, Baton Rouge.
C. M. Higgins.
Highw Res Rec, No 284, p. 51-62, 1969. 12 p, 10 fig, 19 ref.

Descriptors: *Shear strength, *Soil tests, *Cohesive soils, Shear tests, Soil compression tests, Soil engineering, Soil mechanics, Soil properties, Soil strength, Unconfined compression, Test procedures, Apparatus, Bibliographies.
Identifiers: *Menard pressuremeter, *Comparative studies, Pressure probes, Correlation, In situ tests, Testing equipment.

Shear strengths of cohesive soils obtained in place in boreholes using the Menard pressuremeter system are compared to strengths obtained by unconfined compression tests and by consolidated undrained triaxial tests. Correlation was good for soft, fairly uniform soils, but the pressuremeter showed consistently higher strengths in soils interspersed with materials different from the majority of the material and in soils with other types of discontinuity. The pressuremeter yields a strength prediction between that of the majority of the material and that of the weaker areas in the sample. Conventional test strengths probably are those of the weakest areas in the cores. Advantages of the pressuremeter are: (1) portability; (2) performs the test in place, causing less disturbance to the tested material; and (3) faster and somewhat more economical use. Disadvantages are: (1) extreme sensitivity to hole size, (2) sharp aggregates within the sample may burst the probe, and (3) special methods probably will be required for noncohesive soils. Pressuremeter-derived strengths are closer to the average confined in-place strength of the soils than those obtained by conventional methods. (USBR)
W70-04634

DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
Indiana State Highway Commission.
R. P. Dove, T. G. Williamson, and H. R. J. Walsh.
Highw Res Rec, No 284, p 37-50, 1969. 14 p, 9 fig, 1 tab, 7 ref.

Descriptors: *Compaction tests, *Laboratory tests, *Granular materials, *Impact tests, Laboratory equipment, Test procedures, Cohesionless soils, Soil tests, Soil density, Soil compaction, Soil engineering, Soil mechanics, Moisture content, Construction materials, Apparatus, Materials testing, Optimum moisture content.
Identifiers: *Testing equipment, *Construction control, Comparative studies, Vibratory compaction, Equipment design, Correlation.

Development of apparatus and procedures for a laboratory compaction test aimed at simulating field compaction of granular materials is described. The technique includes: (1) use of larger molds (6 in. dia by 9 in. high) and utilization of all sizes of aggregate (up to 1-1/2 in.) commonly used in Indiana for base and subbase materials; (2) compaction in one layer (similar to a field lift) approximately 9 in. in original thickness and 6 in. when compacted; (3) a head plate that covers the entire sample surface; and (4) compaction by impacts from a vibratory shaker and by standard drop hammers. Moisture-density curves obtained on Indiana granular base and subbase materials are compared to curves from Standard and Modified AASHO methods, and certain problems of technique are discussed. Relatively steep compaction curves are obtained using the method and maximum density values can be determined accurately. (USBR)
W70-04635

GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
Army Engineer Waterways Experiment Station, Vicksburg, Miss.
E. L. Krinitzsky, and Charles R. Kolb.
Proc 7th Annu Eng Geol Soils Eng Symp, p 160-175, Moscow, Idaho, Apr 1969. 16 p, 9 fig, 16 ref.

Descriptors: *Engineering, *Slope stability, *Clay shales, Geology, Effects, Stability, Soil mechanics, Structural relaxation, Slopes, Precipitation (Atmospheric), Bibliographies, Weathering, Groundwater, Landslides, Erosion, Shales, Topography, Mineralogy, Structure.
Identifiers: Geologic defects, Sliding resistance, Rock slope.

Influences of lithology, erosion, structural relaxation, weathering, local topography, precipitation and ground water, rock structure, and rock fabric on the stability of clay shale slopes are discussed. Stability is determined by combinations of these factors; the importance of each can vary over short distances. Major influences are the various aspects of lithology, structure, and ground water. Several examples of landslides are cited. (USBR)
W70-04644

8F. Concrete

RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
R. Jones, and I. Facaoaru.
Mater Struct, Vol 2, No 10, p 275-284, July-Aug, 1969. 10 p, 5 fig, 5 tab.

Descriptors: Concrete construction, Concrete control, Concretes, Wave velocity, Concrete structures, Concrete technology, *Concrete testing, *Ultrasonics, Elasticity modules, Elasticity (Mechanical), Poisson ratio, Compressive strength, Instrumentation, Measuring instruments.
Identifiers: *Concrete properties, Foreign testing, Great Britain, *Ultrasonic impulse method, Soniscopes, *Pulse velocity tests.

Recommendations are given for application of the ultrasonic pulse method to determine elastic properties, strength, homogeneity, location of internal defects, and changes in concrete properties. Methods of measuring pulse velocity and influence of test conditions on accuracy are discussed. The recommended procedures should lead to better standardization of measuring techniques. Interpretation difficulties arise in deriving elastic properties and strength from in situ measurements of pulse velocity, but may be overcome by following the recommended methods. (USBR)
W70-04620

RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
Institute for Building Technics, Warsaw (Poland).
L. Brunarski.
Mater Struct, Vol 2, No 10, p 269-273, July-Aug, 1969. 5 p, 6 tab.

Descriptors: Vibrations, *Non-destructive tests, Instrumentation, Test procedures, Test specimens, Testing, Transverse waves, Longitudinal waves, Elasticity (Mechanical), *Elasticity modulus, *Concrete testing, Concretes, Concrete technology, *Natural frequency, Materials testing.
Identifiers: *Resonance frequency method, Foreign testing, *Torsional resonant frequency, *Rigidity modulus.

Recommendations on resonance frequency methods for testing concrete, accepted at the RILEM Working Group Meeting on Nondestructive Testing of Concrete held at Varna, Bulgaria, in Sept 1968, are presented. The recommendations were developed by members of Working Groups from Czechoslovakia, Japan, Poland, Soviet Union, United Kingdom, and United States. Specific recommendations are given for: apparatus characteristics; shape, dimensions, curing conditions, and age of test specimens; specimen support and positioning of driver and pickup for longitudinal, flexural, and torsional modes of vibration; formulas for calculating dynamic elasticity moduli; and symbols and units in SI and MKfs systems. (USBR)
W70-04621

ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
Bureau of Reclamation, Denver, Colo.
G. L. Kalousek.
Bur Reclam General Rep 45, REC-OCE-69-2, Nov 1969. 23 p, 8 fig, 5 tab, append.

Descriptors: *Portland cements, *Concrete technology, *Gypsum, *Concrete additives, *Crystallization, *False set, Hydrates, Differential thermal analysis, Cements, Thixotropy, Hardening, Setting (Materials).
Identifiers: Ettringite, Cement hydration, Cement chemistry, Glossaries.

Abnormal set of portland cement may be due to different combinations of several causes. Gypsum recrystallization was confirmed as one cause. The rate of ettringite precipitation of certain cements treated with organic admixtures correlated with the rate of stiffening of the mortars. Thixotropic set was determinable on cement-benzene slurries with a thixometer, an instrument developed for the purpose. Thixotropic behavior was induced by aeration at 50% R H and persisted in cement-water pastes from about 10 sec to over 11 min. The rate of gypsum and ettringite formation was followed by differential thermal analysis. The causes of and correctives for abnormal set are described. (USBR)
W70-04627

CONCRETE PERFORMANCE IN YELLOWTAIL DAM, MONTANT--5-YEAR CORE REPORT,
Bureau of Reclamation, Denver, Colo.
J. R. Graham.
Bur Reclam Rep C-1321, Oct 1969. 40 p, 20 fig, 14 tab, 2 ref, append.

Descriptors: *Concrete testing, *Mass concrete, Concretes, Compressive strength, Poisson ratio, Concrete control, Elasticity modulus, Concrete dams, Laboratory tests, Concrete technology, Cores, Construction joints, Concrete mixes, Aging (Physical), Physical properties.
Identifiers: Concrete properties, Yellowtail Dam (Mont), Longtime tests.

Laboratory physical properties tests were performed on 10-in.-dia cores drilled from mass concrete in Yellowtail Dam, Mont. Strength and elastic properties were determined on the concrete specimens at 6-mo, 1-, and 5-yr ages. Results indicate a well-designed, properly consolidated, good-quality concrete. The study is part of a series in the Bureau of Reclamation's 20-yr evaluation of strength and elastic properties, of concrete in various dams. Some findings based on tests of the cores are: (1) strength development continued to 5-yr age; (2) vertically drilled cores exhibited higher compressive strengths than cores drilled horizontally; (3) modulus of elasticity increased somewhat to 5-yr age; and (4) wet-sandblast-prepared construction joints are better than those prepared by water jetting. Cement efficiencies, coefficient of variation of strengths, and other properties are discussed. (USBR)
W70-04628

PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
American Concrete Inst., Detroit, Mich.
William R. Waugh, Martin W. Boll, and George F. Bowden.
Amer Concr Inst J Proc, Vol 66, No 10, p 798-813, Oct 1969. 16 p, 12 fig, 32 ref.

Descriptors: *Concrete construction, *Precast concrete, *Formwork (Construction), Architecture, Concretes, Bonding, Bridges, Mass concrete, Buildings, Concrete technology, Floors, Bibliographies, Concrete dams, Hydraulic structures, Joints (Connections), Reinforced concrete, Roofs, Structural design, Prestressed concrete, Walls.
Identifiers: Bond, Concrete blocks.

Precast concrete units, unreinforced, reinforced, or prestressed, are used as forms for cast-in-place and precast concrete. Precast units as forms for cast-in-place and precast concrete. Precast units as forms for cast-in-place work are discussed, showing how such units are used: (1) as structurally adequate for applied loads and concrete pressures without support except ties and alinement braces, or (2) as liners for forms made of other materials. The concrete forms may be removed after casting or remain in place as a permanent part of the structure. A principal application of stay-in-place forms has been as architectural facing, but some become structurally composite with the cast-in-place concrete. Development of various types of precast forms including ferrocement and facing slabs for mass concrete and hydraulic structures is surveyed, but the main concentration is on structural and architectural uses most prevalent in the U.S. and Canada. Typical formwork installations are described, and factors influencing use are discussed. Design and construction requirements for this type of formwork are outlined and suggestions for handling, erection, and use of precast forms are made. Recommendations are given for treatment of joint and connection details and for bond and anchorage of the form units. (USBR)
W70-04629

LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
Bechtel Corp., San Francisco, Calif.
Harry Sutcliffe, and Cole R. McClure.
Civ Eng, Vol 39, No 11, p. 51-55, Nov 1969. 5 p, 3 fig, 3 photo.

Descriptors: *Tunnel linings, *Gunite, *Pumped concrete, *Tunnel construction, Construction, Tunneling, Creep, Aggregates, Compressed air, Accelerators, Reinforcing, Underground structures, Axial loads, Durability.
Identifiers: *Tunnel supports, *Sprayed concrete, *Concrete linings, Compressive stress.

A growing need for underground construction exists in transportation, pumped storage, pollution control, and defense works. The rate of growth of tunnel construction is limited only by the higher cost when compared with above-ground construction. A substantial portion of the cost of underground work is in the support and lining of the excavation, and making this area more economical is important. Any acceleration of the rate that support or lining can be placed permits the use of faster tunneling machines and reduces costs. Gunite, a pneumatically applied cement mortar used in canal linings, has been used with wire-mesh reinforcement in tunnels to prevent slaking and spalling

of the ground, with good durability and resistance to abuse. The spraying of large-aggregate concrete was only mildly successful until European research with chemical accelerators provided a means of controlling the rate of strength buildup of the sprayed material. Use of accelerators started the changes in application practices and furthered the acceptance of shotcrete in underground work. First used in combination with steel ribs and wire mesh shotcrete is used more frequently unreinforced. (USBR)
W70-04636

8G. Materials

COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
General Motors Corp., Warren, Mich. Dept. of Chemistry; and Connecticut Univ., Storrs. Corrosion Research Lab.
W. D. France, Jr., and N. D. Greene.
Corrosion, Vol 26, No 1, p 1-4, January 1970. 4 p, 5 fig, 1 tab, 19 ref. OSW Grant No 14-01-0001-458.

Descriptors: *Pitting (Corrosion), *Corrosion, *Brines, *Desalination apparatus, *Stainless steel, Saline water, Saline water systems, Water chemistry, Chemical reactions, Electrolysis, Metallurgy, Corrosion control.
Identifiers: Zirconium.

Studies of pitting of zirconium and stainless steel in acidic and near-neutral chloride media show that controlled potential and conventional chemical corrosion tests do not yield similar rates or types of attack under identical environmental conditions. Such discrepancies limit critical pitting potential measurements and related techniques for evaluating and comparing pitting in halide environments like those in desalination equipment. A theoretical explanation based on the accumulation of chloride at anodically polarized electrode surfaces is presented. (Knapp-USGS)
W70-04550

THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
Union Carbide Corp., Oak Ridge, Tenn.
James H. Smith.
Exp Mech, Vol 9, No 11, p 23N-28N, Nov, 1969. 6 p, 12 fig.

Descriptors: *Digital computers, Computer programming, Computers, Data processing, Data reduction, Experimental data, *Materials testing, Mechanical properties, *Metals testing, Laboratory tests, Testing, Testing machines, Stress-strain curves, Computation.
Identifiers: Analog-to-digital converter, Display systems, *Testing equipment, Test results, Strain energy, Computer printouts.

A digital computer may be programmed to record raw data and to provide automatic data calculations for mechanical tests. An evaluation is given of a computer system connected to a universal testing machine and a torsion tester. The computer is connected to the testing machines by an analog-digital converter. The system records raw load-strain data, converts to stress-strain data, and calculates any mechanical properties desired from the test. The computer also can provide a printout and a paper tape of the data. An oscilloscope display is obtained as data are recorded. Tensile, compression, pin bearing, double shear, and torsion tests are being performed. Data being recorded include ultimate strength, offset yield strength, elastic and shear moduli, energy under the stress-strain curve, and a mathematical expression for the stress-strain curve. In addition to the mechanical load-strain curve provided by the test machine, the computer can provide a stress-strain curve and a listing of stress-strain data points. (USBR)
W70-04624

MEASURING MOISTURE WITH GAMMA RADIATION,
F. E. McKinney.
Isotop Radiat Technol, Vol 7, No 1, p. 29-35, Fall 1969. 7 p, 7 fig, 2 tab, 23 ref.

Descriptors: *Gamma rays, *Moisture content, *Moisture meters, *Nuclear moisture, *Soil moisture, Moisture, Bibliographies, Reviews, Density, Radioisotopes, Ceramic materials, Radioactivity techniques, Cobalt radioisotopes, Soils, Soil moisture, Peat, Cements, Wood, Textiles, Fibers, Materials, Test procedures, Soil mechanics.
Identifiers: *Gamma probes, *Nuclear density meters, *Water content, Cesium radioisotopes.

Determining the amount of moisture in a given substance is a necessary part of many physical and chemical processes. Neutron moisture gages are used for this purpose, based upon the moderation of neutron by hydrogen. However, many substances have hydrogen as part of their chemical composition and neutron measurements would be in error for these materials. Gamma radiation may be used for an indirect determination of moisture content; gamma radiation is used to measure the densities of a dry sample and a moist sample, and moisture is determined with the assumption that the difference in densities is the result of the difference in water content. Applications of gamma radiation to determine the moisture content in soil, peat, wood, ceramics, construction materials, meat, and textile fibers are reviewed. The source isotopes were Cobalt 60 and Cesium 137 used at strengths of 1 mc to 10 curies of Cobalt 60, and 5 mc to 251 mc of Cesium 137. (USBR)
W70-04641

CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
Titanium Metals Corp. of America, West Caldwell, N.J.
N. G. Feige.
Preprint SM-113/25 of Paper Presented at IAEA Symp. Nucl. Desalination, Madrid, Spain, Nov. 18-22, 1968. 20 p, 7 fig, 16 ref.
Identifiers: *Corrosion tests, *Titanium, *Titanium alloys, Corrosion, Corrosion control, Corrosion problems, Crevice corrosion, Fabrication materials, Heat transfer, Pitting (Corrosion), Tubing (Metal).

A review of corrosion evaluation studies and subsequent alloy development program has resulted in a series of titanium base alloys suitable for service at temperatures up to 350 deg F. A critical area in a nuclear desalination plant is the interface between the primary water or steam in the nuclear system and the hot concentrated brine in the desalting plant. Titanium, because of its compatibility with both environments, has been considered in these heat exchangers to reduce the probability of tube failure. In the nuclear system under primary water conditions titanium appears to suffer no corrosion attack other than the buildup of an adherent oxide tarnish film. In the hot brine environment pitting corrosion or crevice corrosion at elevated temperatures limits a commercially pure alloy as heat exchanger tubing to service below 250 deg F. The laboratory experimental techniques developed during this program are reviewed. The information obtained from each test is related to the mechanism of corrosion attack, and the available alloy additions and their effect in modifying the rates of reaction are reviewed. Field service experience with titanium is reviewed and related to the laboratory test program.
W70-04667

ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
Battelle Memorial Inst., Columbus, Ohio.
F. W. Fink.
Copper Develop. Assoc. Tech. Rept. 704/6, June, 1966. 38 p, 37 ref.
Identifiers: *Corrosion, *Fabrication materials, *Heat exchangers, Aluminum, Copper, Copper alloys, Stainless steels, Titanium.

Copper alloys have long been used for heat exchangers in applications involving seawater since they have a unique combination of properties which make them an excellent choice for this service. One of the oldest of these alloys, arsenical admiralty (copper alloy no. 443), still can be useful in the less severe, lower temperature stages of a multieffect distillation plant. Arsenical aluminum brass (copper alloy no. 687) has shown excellent performance in hot seawater applications and is widely used. However, for the higher temperature stages in some of newer plants the copper nickels are preferred. Many designers favor the iron-modified 90-10 copper nickel (copper alloy no. 706), since it is superior to the aluminum brass in performance, and is less costly than the iron-modified 70-30 copper nickel (copper alloy no. 715). The higher nickel content alloy is favored where the severe service conditions are beyond the range of presently available information. Quantitative long-term corrosion data for copper alloys are urgently needed. Present information comes from limited experience with pilot or demonstration plants or from spool-test-type specimens immersed in the seawater streams of such plants.
W70-04929

TITANIUM TUBES NOW FIGHT SEA WATER,
Harvey Aluminum, St. Croix, Virgin Islands.
M. H. Sims.
Power, Vol. 112, No 9, p 63-65, 1968. 5 fig.
Identifiers: *Corrosion, *Heater-evaporator tubes, *Operating experience, *Titanium, Corrosion control, Crevice corrosion, Erosion corrosion, Evaporators, Fabrication materials, Tubing (Metal).

After 2 years of continuous operation the titanium tubing in the multistage flash distillation plant at St. Croix, V.I., shows no sign of tube erosion or crevice corrosion. The plant was constructed by Westinghouse for Harvey Aluminum to produce 0.75 MGD at 185 deg F or 1.5 MGD at 250 deg F. The plant has 0.028-in.-thick tubes, 5.8-in.-dia in the evaporator and 1-in.-dia in the heat reject and heat recovery sections. The plant has been operating at 220-250 deg F with an output of 1 MGD. No scaling problems have been encountered - on-stream avid cleaning of the tubes was used when some tube fouling was indicated.
W70-04931

CORROSION OF MILD STEEL UNDER OPERATING CONDITIONS OF A DISTILLATION DESALTING PLANT.

Desalination Vol 5, p 90-94, 1968. 4 fig. Also Preprint from 2d European Symp.-Fresh Water From The Sea, Vol 4, Athens, May, 1967.
Identifiers: *Corrosion, *Fabrication materials, *Low alloy steels, Corrosion tests, Deaeration, Experimental data, Research results.

The influence of temperature, salinity, chloride, sulfate, and seawater velocity on the corrosion resistance of mild steel was investigated to determine the possibilities of its application to desalting plants. The maximum corrosion of mild steel in caspian seawater under static conditions is 0 to 15 MM/YR (at 90 deg C) and with flow at a velocity of 1 to 2 M/SEC is 1 to 25 MM/YR (at 70 deg C). The corrosion rate of mild steel decreases abruptly in oxygen-free seawater under static conditions and is not higher than 0 to 0.01 MM/YR at 90 deg C. If mild steel is in contact with copper-base alloys or stainless steel, corrosion increases greatly. Maximum corrosion of mild steel in contact with electropositive materials in moving seawater is 2 to 3 MM/YR at 70 deg C. On the basis of these results, mild steel is recommended as a construction material for distillation plants if the seawater is deaerated and there is no contact with electropositive materials.
W70-04949

8H. Rapid Excavation

LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
Bechtel Corp., San Francisco, Calif.
For primary bibliographic entry see Field 08F.
W70-04636

10. SCIENTIFIC AND TECHNICAL INFORMATION

RESOURCE CONSERVATION GLOSSARY,
D. E. Hutchinson, and A. D. Stoesz.
Journal of Soil and Water Conservation, Vol 25, No 1, p 1G-52G, January-February 1970. 52 p, 30 ref.

Descriptors: *Publications, *Documentation, *Soil conservation, *Water conservation, Geology, Hydrology, Biology, Forestry, Economics, Ecology, Agronomy, Conservation, Engineering, Recreation, Ranges, Soils, Watershed management.
Identifiers: *Glossaries.

A glossary of resource conservation includes terms used in studies of agronomy, biology, conservation, ecology, economics, engineering, forestry, geology, hydrology, ranges, recreation, soils, and watersheds. The glossary is intended to serve as a reference for professionals, students, and laymen. (Knapp-USGS)
W70-04559

VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
System Development Corp., Santa Monica, Calif.
For primary bibliographic entry see Field 7C.
W70-04600

SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
Leeds, Hill and Jewett, Inc., San Francisco, Calif.
Harvey O. Banks, and Charles G. Wolfe.
Available from the Clearinghouse as PB-190 398, $3.00 in paper copy, $0.65 in microfiche. Supplement of Report prepared for Office of Water Resources Research, Department of Interior, 1970. 13 p, 21 ref. OWRR Contract No 14-01-0001-1618.

Descriptors: *Publications, *Reviews, Water law, Social aspects, Planning, Surveys, Documentation, Editing, Technical societies, Water resources development.
Identifiers: *Water resources information, Information exchange.

The use and availability of water resources information to professionals in law, planning, and sociology is surveyed. Several of the most widely circulated periodicals in each of the disciplines under consideration were examined for the years 1965-1969 to ascertain what the readers of these publications could have learned from them concerning water resources problems. None of the publications examined has devoted a great deal of attention to water resources. If increased attention to water resources is to be stimulated beyond what may occur in any event, there must be an understanding of the audience to be reached and of the purposes that publications for the nonspecialist may be expected to serve. A significant part of the responsibility for disseminating technical information to experts in other disciplines should be assumed by persons other than those who initially do the research and write the monographs setting forth their findings. (Knapp-USGS)
W70-04693

AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
Environmental Technical Applications Center (Air Force), Washington, D.C.
For primary bibliographic entry see Field 02B.
W70-04981

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
Minnesota Univ., Minneapolis. Heat Transfer Lab.
For primary bibliographic entry see Field 08B.
W70-05043

SUBJECT INDEX

ABSORPTION
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

ACCIDENTAL POLLUTION
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
W70-04882 05G

ACCIDENTS
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

ACCRETION(LEGAL ASPECTS)
GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

W70-04872 06E

W70-04873 06E

WATER RIGHTS IN TENNESSEE,
W70-04874 06E

ACID DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

ACQUATIC ENVIRONMENT
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

ACTIVATED CARBON
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

ECONOMICS OF RECLAIMED WATER IN DYEWORKS.
W70-04946 05D

ACTIVATED SLUDGE
EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
W70-04588 05D

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

BIOLOGICAL TREATMENT SOLVES DYEWORKS EFFLUENT PROBLEMS,
W70-04961 05D

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

ACTIVATED SLUDGE PARTICLE
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

ADHESIVE FORCES
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

ADJUDICATION PROCEDURE
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04865 06E

ADMINISTRATION
ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

ADMINISTRATIVE AGENCIES
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04868 06E

ADSORPTION
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

ADVANCED WASTE TREATMENT
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

AERATED LAGOON DESIGN
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

AERATED LAGOONS
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

AERATED STABILIZATION PONDS
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

AERATION
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

AERATION TIME
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

AERIAL INTERPRETATION
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

AERIAL PHOTOGRAPHY
SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

AEROBIC PONDS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

AEROBIC SYSTEMS
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

AGGREGATES
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

AGRICULTURAL WASTES
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

AGRICULTURAL WATERSHEDS
LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

AIR CIRCULATION

ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

AIRBORNE SURVEYING
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

ALASKA
SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

ALBEDO
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

ALGAE
THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
W70-04809 02H

DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

ALGAL CONCENTRATION
EXTRA-DEEP PONDS,
W70-04790 05D

ALGAL PHYSIOLOGY
BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

ALLOCATION
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

ALLUVIAL CHANNELS
FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
W70-04599 02J

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
W70-05023 02E

ALUMINATES
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

ALUMINUM
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

AMMONIA
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

ANADROMOUS FISH
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

ANAEROBIC CONDITIONS
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

ANAEROBIC DIGESTION
TREATMENT OF WOOL WASTES,
W70-04626 05D

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
W70-04807 05D

ANAEROBIC FILTER PROCESS
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

ANAEROBIC PONDS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

ANAEROBIC PONDS(PRE-TREATMENT)
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

ANAEROBIC PROCESS DESIGNS
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

ANAEROBIC SLUDGE DIGESTION
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

ANAEROBIC SYSTEMS
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

ANAEROBIC TREATMENT
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

ANAEROBIC WASTE PONDS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

ANAEROBIC WASTE TREATMENT
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

ANALOG MODELS
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

ANALYTICAL TECHNIQUES
ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

ANALYTICAL TREATMENT
SOME DIFFERENCES BETWEEN BRITISH, AMERICAN, AND CONTINENTAL PRACTICE,
W70-04971 05D

ANTARCTIC
EARTH, AIR, WATER,
W70-04585 05B

CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

AQUATIC BACTERIA
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

AQUATIC ENVIRONMENT
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

AQUATIC HABITATS
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

AQUATIC LIFE
PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

AQUATIC MICROORGANISMS
SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

AQUIFERS
UNDER THE RUG,
W70-04589 05G

VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

ARCTIC OCEAN
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

ARID CLIMATES
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

ARID LANDS
ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

ARIZONA
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

THE WATER SITUATION,
W70-04914 03B

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

ARTIFICIAL AERATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

ARTIFICIAL RECHARGE
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
W70-04608 04B

CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
W70-04615 02K

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

ASHLAND LAKE(MISSOURI)
SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

ATLANTIC COASTAL PLAIN
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

ATTERBURY EXPERIMENTAL WATERSHED
EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

AUSTRALIA
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

AUTOMATED METHODS
AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

AUTOMATIC CONTROL
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

AUTOMATION
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

AVOIDANCE REACTIONS
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

AXIAL FLOW
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

BACTERIA
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

BACTERIAL FLOCCULATION
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

BACTERIOPHAGE
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

BANK EROSION
BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
W70-05022 04A

BASE FLOW
PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
W70-04581 02A

BASIC DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

BATCH DESALINATION PROCESS
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

BAYS
SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

BEACH EROSION
THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
W70-04566 02L

BEACHES
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

BEAMS(STRUCTURAL)
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

BED LOAD
FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
W70-04599 02J

BENEFICIAL USE
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
W70-04879 06E

BENEFITS
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

BENTHIC FAUNA
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

BENTONILE
TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONIT
W70-04967 05D

BERING SEA
A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

BIBLIOGRAPHIES
OCEANIC MIXING,
W70-04697 02L

AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

BIOASSAY
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

BIOASSAYS
DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

BIOCHEMICAL OXIDATION DEMAND
I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

CHEMICAL NATURE OF EFFLUENTS FROM THE TEXTILE, LEATHER, AND PAPER INDUSTRIES,
W70-04969 05A

BIOCHEMICAL OXYGEN DEMAND
EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
W70-04588 05D

TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

PROBABILISTIC VARIATIONS IN ULTIMATE FIRST STAGE BOD,
W70-04711 05D

PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
W70-04975 05D

BIOCHEMICAL OXYGEN DEMAND(BOD)
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

BIOCHEMICAL REACTIONS
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

BIOCHEMISTRY
PROBABILISTIC VARIATIONS IN ULTIMATE FIRST STAGE BOD,
W70-04711 05D

BIODEGRADABILITY
III. PROBLEMS OF TEXTILE CHEMICAL WASTES,
W70-04852 05D

BIODEGRADATION
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

BIOLOGICAL AERATION
TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

BIOLOGICAL COMMUNITIES
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

BIOLOGICAL FILTERS
PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
W70-04797 05D

BIOLOGICAL FILTRATION
A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

BIOLOGICAL FLOCCULATION
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

BIOLOGICAL OXIDATION
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

BIOLOGICAL PROCESSES
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

BIOLOGICAL PROPERTIES
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

BIOLOGICAL PURIFICATION
DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

BIOLOGICAL SYSTEMS
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

BIOLOGICAL TREATMENT
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

THE TREATMENT OF STRONG INDUSTRIAL WASTES ON THE CONTINENT,
W70-04965 05D

SOME DIFFERENCES BETWEEN BRITISH, AMERICAN, AND CONTINENTAL PRACTICE,
W70-04971 05D

BLEACHING PLANT WASTES
SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

BOD LOADING
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

BOD REMOVAL
EXTRA-DEEP PONDS,
W70-04790 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

BOLL TEMPERATURE
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

BOTTOM SEDIMENTS
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

BOUNDARY LAYER
EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

BRACKISH WATER
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

BRANDOL-TUBE AERATOR
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

BRAZIL
USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05034 02E

BRINE DISPOSAL
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

BRINE HEATERS
OPTIMUM BRINE HEATER OUTLET TEMPERATURE IN SEA WATER CONVERSION EVAPORATORS.
W70-04955 03A

BRINES
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
W70-04570 02K

GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

BRITISH COLUMBIA
CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

BRUSH CONTROL
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

BUBBLE AERATION
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

BUBBLE DYNAMICS
A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

BUREAU OF RECLAMATION
ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

BY-PRODUCT RECOVERY
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

CALCINATION
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

CALIFORNIA
DESALTING CALIFORNIA,
W70-04583 05G

REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

CALIFORNIA WATER PLAN
REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

CANADA
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

CANAL SEEPAGE
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

CANNING INDUSTRY
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

CANNING WASTE
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

CANOPY
CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

CANOPY RESISTANCE
CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

CAPE COD
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

CAPITAL
THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

CAPITAL COSTS
ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
W70-04650 04B

CARBON DIOXIDE ANALYSIS
TESTS OF DEAERATOR AT THE FREEPORT SEAWATER DESALTING PLANT AND EVALUATION OF DISSOLVED GAS ANALYSIS.
W70-04954 03A

CARBON DIOXIDE REMOVAL
DEAERATORS FOR DESALINATION PLANTS.
W70-04659 03A

CARBON STEELS
CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

CAROTENOIDS
PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

CARPET MILL WASTES
ECONOMICS OF RECLAIMED WATER IN DYEWORKS.
W70-04946 05D

CARPETS
TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

CARTER-PEARTH GAS RECIRCULATION SYSTEMS
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

CAUSTIC
SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
W70-04637 05D

SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

CAUSTIC RECOVERY
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

CAUSTIC SODA
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

CHANNEL IMPROVEMENT
FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
W70-04750 04A

CHEMICAL ADDITIVES
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

CHEMICAL ANALYSIS
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

CHEMICAL ENVIRONMENT
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

CHEMICAL PRECIPITATION
CHEMISTRY OF MANGANESE IN NATURAL WATERS,
W70-04558 02K

THE TREATMENT OF STRONG INDUSTRIAL WASTES ON THE CONTINENT,
W70-04965 05D

FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

CHEMICAL PROPERTIES
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

CHEMICAL REMOVAL
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

CHEMICAL WASTES
WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

CHESAPEAKE BAY
THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

CHICAGO
BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

CHLORINATION
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

CITY PLANNING
BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

CLAIR ENGLE PLANT
CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
W70-04660 03A

RECYCLE BOOSTS DESALTING EFFICIENCY,
W70-04938 03A

CLARIFICATION
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

CLARIFIERS
DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

CLASSIFICATION
ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

WHAT IS AN ESTUARY PHYSICAL VIEW POINT,
W70-05014 02L

CLAY SHALES
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

CLEAR-CUTTING
PREDICTING THE EFFECT OF CLEARCUTTING ON STREAM TEMPERATURE,
W70-04556 04C

CLIMATES
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

CLIMATIC CONDITIONS
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

CLIMATIC DATA
AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

CLIMATIC ZONES
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

CLIMATOLOGY
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

CLINOPTILOLITE
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

COAGULATING
APPLICATION OF CHLORINE AND TREATMENT OF TEXTILES WASTES,
W70-04974 05D

COAGULATION
CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

COASTS
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

COEFFICIENT OF DIFFUSION
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

COHESIVE SOILS
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

COLD REGIONS
UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

COLD WEATHER CONSTRUCTION
UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

COLLARDS
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

COLLISION FREQUENCY
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

COLLOIDS
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

COLOR REMOVAL
CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

COLORADO
HYDRAULIC TESTING AND SAMPLING OF USBR-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

COLUMNS(PROCESS)
FLOW THROUGH IRRIGATED DUMPED PACKINGS--PRESSURE DROP, LOADING, FLOODING,
W70-04678 03A

COMPACTION TESTS
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

COMPARATIVE STUDIES
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

COMPONENT DEVELOPMENT
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

COMPONENT TESTING
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

COMPOSITE BEAMS
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

COMPREHENSIVE ENVIRONMENTAL PLANNING
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

COMPUTER MODELS
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON RUKEWATER CREEK, TEXAS,
W70-04726 04C

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

COMPUTER PROGRAMS
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

COMPUTERIZED DESIGNS
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

CONCEPTUAL DESIGNS
CONCEPTUAL DESIGN STUDY OF A ONE MILLION GALLON PER DAY RSH DESALINATION PLANT - REPLACEMENT FOR DEMONSTRATION PLANT NO. 2 AT POINT LOMA, SAN DIEGO, CALIFORNIA.
W70-04674 03A

CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART I, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

CONCRETE ADDITIVES
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

CONCRETE CONSTRUCTION
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

CONCRETE LININGS
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

CONCRETE PROPERTIES
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

CONCRETE TECHNOLOGY
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

CONCRETE TESTING
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

CONCRETE PERFORMANCE IN YELLOWTAIL DAM, MONTANT--5-YEAR CORE REPORT,
W70-04628 08F

CONDENSATION PROMOTERS
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

CONDENSERS
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

CONDENSING
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

CONE AERATION
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

CONFERENCES
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

CONJUNCTIVE USE
REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
W70-04650 04B

CONSERVATION
ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

CONSTRUCTION CONTROL
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

CONTINENTAL SHELF
ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
W70-05016 02L

CONTINUITY EQUATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

CONTINUITY EQUATIONS
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

CONTROL
CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

CONTROL STRUCTURES
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

CONTROL SYSTEMS
EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
W70-04623 08C

CONVECTION
A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

ADVANCES IN FREE CONVECTION,
W70-05038 08B

TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
W70-05041 08B

COORDINATION
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04869 06E

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

COPPER ALLOYS
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

CORE DRILLING
CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

CORRELATION ANALYSIS
QUANTITATIVE ANALYSIS OF RESIDENTIAL WATER-USE PATTERNS IN MAYAGUEZ, PUERTO RICO,
W70-04830 06D

CORROSION
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
W70-04929 08G

TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

CORROSION OF MILD STEEL UNDER OPERATING CONDITIONS OF A DISTILLATION DESALTING PLANT.
W70-04949 08G

CORROSION CONTROL
SOME PRACTICAL ASPECTS OF DESALINATION BY EVAPORATION,
W70-04657 03A

CORROSION TESTS
CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
W70-04667 08G

COST ANALYSIS
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

TEXTILE WORKS EFFLUENT TREATMENT,
W70-04831 05D

COST COMPARISONS
WATER RESOURCES VALUES,
W70-04762 05D

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

COST SHARING
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

COSTS
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

COST-BENEFIT ANALYSIS
THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
W70-04648 05D

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

WATER RESOURCES VALUES,
W70-04762 05D

COTTON
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

COTTON FINISHING WASTES
POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

CRABS
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

CROP PRODUCTION
AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

CROP RESPONSE
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

CRYSTALLIZATION
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

CULTURAL EUTROPHICATION
SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

CURRENTS(WATER)
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

CZECHOSLOVAKIA
CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

C N RATIO
NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

DAM DESIGN
. . . THE ROMAN DAMS OF SUBIACO,
W70-04980 08A

DAM FAILURE
. . . THE ROMAN DAMS OF SUBIACO,
W70-04980 08A

DAMS
EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
W70-04571 04A

JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

DANJES SYSTEM
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

DATA COLLECTIONS
TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

DATA PROCESSING
ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
W70-04600 7C

DATA REQUIREMENTS
INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

DATA STORAGE AND RETRIEVAL
VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
W70-04600 7C

DEAD ZONE MODEL
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

DEAERATION
DEAERATORS FOR DESALINATION PLANTS.
W70-04659 03A

FLOW THROUGH IRRIGATED DUMPED PACKINGS--PRESSURE DROP, LOADING, FLOODING,
W70-04678 03A

DEAERATORS
DEAERATORS FOR DESALINATION PLANTS.
W70-04659 03A

DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
W70-04668 03A

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
W70-04669 03A

FLOW THROUGH IRRIGATED DUMPED PACKINGS--PRESSURE DROP, LOADING, FLOODING,
W70-04678 03A

TESTS OF DEAERATOR AT THE FREEPORT SEAWATER DESALTING PLANT AND EVALUATION OF DISSOLVED GAS ANALYSIS.
W70-04954 03A

DECISION MAKING
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04544 06A

WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

DELAWARE RIVER BASIN COMMISSION
THE DELAWARE RIVER BASIN COMMISSION, A PROTOTYPE IN RIVER BASIN DEVELOPMENT,
W70-04824 06B

DELTAS
EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
W70-05000 02L

DEMAND
DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

DEMINERALIZATION
FRESH WATER SUPPLIES THROUGH DESALINATION,
W70-04647 03A

DEMONSTRATION WATERSHEDS
LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

DENITRIFICATION
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

DENMARK
ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

DENSITY
RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

DEPTH EFFECTS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

DESALINATION
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

DESALINATION APPARATUS
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

DESALINATION PLANTS
RELATIONSHIP BETWEEN STORAGE CAPACITY AND LOAD FACTOR OF A DESALINATION PLANT,
W70-04905 03A

DESALINATION PROCESSES
VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

DESIGN
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

THE OPTIMAL DESIGN OF DESALINATION SYSTEMS.
W70-04957 03A

PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

DESIGN CRITERIA
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3.

ENGINEERING DESIGN,
W70-04549 05D

NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

DESIGN DATA
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

DESIGN THEORY AND CALCULATIONS
BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

DESIZING WASTES
POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

DESLAINATION
FRESH WATER SUPPLIES THROUGH DESALINATION,
W70-04647 03A

DETENTION TIME EFFECTS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

DETERGENTS
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
W70-04885 05G

DEVELOPED DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

DEWATERING
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

DE-SIZING
ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
W70-04807 05D

DIAGENESIS
DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

DIATOMS
PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
W70-04902 05C

DICHLOROPHENOXYACETIC ACID
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

DIELECTRIC PROPERTIES
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

DIELECTRICS
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

DIFFUSION
A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

CIRCULATION AND DIFFUSION,
W70-05004 02L

DIGESTION
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

DIGITAL COMPUTERS
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

DILUTION METHOD
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

DIRECT CONTACT HEAT EXCHANGE
ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

DIRECT CURRENT
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

DIRECT DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

DISCHARGE MEASUREMENTS
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

DISCHARGE(WATER)
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

DISCOUNT RATE
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04825 06B

W70-04826 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION-VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04827 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04828 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II· VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

DISPERSION
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

DISPOSAL
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

DISPOSAL BY IRRIGATION
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

DISRUPTIVE FORCES
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

DISSOLVED OXYGEN
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

DISSOLVED OXYGEN CONCENTRATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

DISSOLVED OXYGEN DEFICITS

ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

DISTILLATION PROCESSES
SOME PRACTICAL ASPECTS OF DESALINATION BY EVAPORATION,
W70-04657 03A

ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
W70-04672 03A

THERMAL DISTILLATION OF SEA WATER - FUNDAMENTALS OF THE THEORY OF MARINE EVAPORATORS,
W70-04676 03A

FLASH DESALINATION PLANT - THE RESULTS OF THE FIRST TEN YEARS OF DEVELOPMENT AND FIELD PROVING,
W70-04926 03A

THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

DISTRIBUTION PATTERNS
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

A NOTE ON AREAL RAINFALL DEFINITION,
W70-04719 02B

DIURNAL
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

DIURNAL CURVE
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

DOCUMENTATION
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

DOMESTIC WASTES
WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

II. THE FEASIBILITY OF TREATING TEXTILE WASTES IN CONNECTION WITH DOMESTIC SEWAGE,
W70-04851 05D

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
W70-04882 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
W70-04883 05G

DOUGLAS FIR TREES
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

DRAFT-STORAGE CURVES
DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

DRAINAGE
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
W70-04885 05G

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

DRAINAGE EFFECTS
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

DRAINAGE SYSTEMS
DESALTING CALIFORNIA,
W70-04583 05G

DRAINAGE WATER
DESALTING CALIFORNIA,
W70-04583 05G

DRILLING
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
W70-04885 05G

DROPS(FLUIDS)
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

DROPWISE CONDENSATION
RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
W70-04671 03A

INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

DROUGHT RESISTANCE
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

DRY BEDS
GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

W70-04872 06E

W70-04873 06E

DUAL-PURPOSE PLANT
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

DESIGN, OPERATION, AND RESULTS OF THE LARGEST FLASH-TYPE SEAWATER CONVERSION PLANT AND ITS EFFECT ON FUTURE CONVERSION PLANTS.
W70-04950 03A

DUAL-PURPOSE PLANT ECONOMICS
DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
W70-04670 08C

DUSTS
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

DYEHOUSE WASTES
ECONOMICS OF RECLAIMED WATER IN DYEWORKS.
W70-04946 05D

CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
W70-04960 05D

BIOLOGICAL TREATMENT SOLVES DYEWORKS EFFLUENT PROBLEMS,
W70-04961 05D

PROBLEMS OF EFFLUENT DISPOSAL,
W70-04963 05D

TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
W70-04976 05D

DYEING WASTES
WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

BRINE
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

BIOLOGICAL TREATMENT SOLVES DYEWORKS EFFLUENT PROBLEMS,
W70-04961 05D

DYNAMIC PROGRAMMING
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

ECOLOGY
AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
W70-04597 02H

ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

ECONOMIC AND SYSTEM ANALYSIS
WATER RESOURCES VALUES,
W70-04762 05D

ECONOMIC EVALUATIONS
COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
W70-04675 03A

COMBINED RECOVERY OF POTABLE WATER AND SEA SALT BY EVAPORATION AN ECONOMIC SOLUTION,
W70-04935 03A

THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

THE OPTIMAL DESIGN OF DESALINATION SYSTEMS.
W70-04957 03A

ECONOMIC FEASIBILITY
ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,

W70-04614 04B

ECONOMIC IMPACT
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

MAIN C COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SYSTEM DOCUMENTATION.
W70-04691 06D

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
W70-04983 06B

ECONOMIC JUSTIFICATION
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

ECONOMICS
CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

ECONOMICS OF SCALE
SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

ECOSYSTEMS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

EDDIES
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

EFFICIENCIES
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

EFFLUENT DISPOSAL
PROBLEMS OF EFFLUENT DISPOSAL,
W70-04963 05D

EFFLUENT TREATMENT
TEXTILE WORKS EFFLUENT TREATMENT,
W70-04831 05D

EFFLUENTS
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

EGYPT
ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

ELASTIC DEFORMATION
VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

ELASTICITY(MECHANICAL)
VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

ELECTRIC INSULATION
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

ELECTRIC POWER
EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
W70-04623 08C

ELECTRICAL INSULATION TESTS
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

ELECTRICAL INSULATORS
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

EMPIRICAL MODELS
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

ENDOGENOUS DENITRIFICATION
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

ENERGY
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

ANALYSIS OF WAVE FORCE DATA,
W70-04700 08B

METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

ENERGY BALANCE
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

ENERGY EXCHANGES
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

ENERGY SOURCES
COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
W70-04675 03A

ENERGY TRANSFER
ADVANCES IN FREE CONVECTION,
W70-05038 08B

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

ENERGY-P/R RELATIONSHIP
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

ENGINEERING
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

ENGINEERING EVALUATION
JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

ENTRAINMENT
CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

THE FLOW OF FLASHING WATER IN CONDUITS.
W70-04958 03A

ENVIRONMENT
WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

ENVIRONMENTAL EFFECTS
WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

EQUATIONS
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

EROSION
MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

EROSION CONTROL
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

ESTHETIC EFFECTS
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
W70-04885 05G

ESTIMATION

USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05034 02E

ESTUARIES
STATEMENT OF CONCERN,
W70-04584 05B

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
W70-04716 05B

PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
W70-04993 02L

ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

SALINITY MEASUREMENTS IN ESTUARIES,
W70-04999 02L

EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
W70-05000 02L

CIRCULATION AND DIFFUSION,
W70-05004 02L

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
W70-05010 02J

RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
W70-05012 02L

ORIGIN OF SEDIMENTS IN ESTUARIES,
W70-05013 02L

WHAT IS AN ESTUARY PHYSICAL VIEW POINT,
W70-05014 02L

ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
W70-05016 02L

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

ESTUARINE CIRCULATION
CIRCULATION AND DIFFUSION,
W70-05004 02L

ESTUARINE POLLUTION
NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

ESTUARINE SEDIMENTATION
CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

EUTROPHICATION
LAKE EUTROPHICATION -- A NATURAL PROCESS,
W70-04721 05C

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
W70-04810 02H

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
W70-04993 02L

EVALUATION
THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
W70-04648 05D

MAIN C COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SISTEM DOCUMENTATION.
W70-04691 06D

NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
W70-04983 06B

EVAPORATION
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

EVAPORATION DYNAMICS
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

EVAPORATION ENHANCEMENT
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

EVAPORATION PANS
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

EVAPORATION RATES
DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

EVAPORATIVE FREEZING
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

EVAPORATOR SYSTEM DESIGN
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

EVAPORATORS
SOME PRACTICAL ASPECTS OF DESALINATION BY EVAPORATION,
W70-04657 03A

COMBINED RECOVERY OF POTABLE WATER AND SEA SALT BY EVAPORATION AN ECONOMIC SOLUTION,
W70-04935 03A

EVAPORATOR-CONDENSER SYSTEM DESIGNS
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

EVAPOTRANSPIRATION
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

EVAPOTRANSPIRATION CONTROL
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

EXCESS SLUDGE PRODUCTION
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BASE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

EXCITATION REGULATORS
EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
W70-04623 08C

EXPERIMENTAL SYSTEM

LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

EXPLORATION
SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

EXTENDED AERATION
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

EXTENDED HEAT TRANSFER SURFACES
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

FABRICATION MATERIALS
ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
W70-04929 08G

CORROSION OF MILD STEEL UNDER OPERATING CONDITIONS OF A DISTILLATION DESALTING PLANT.
W70-04949 08G

FACULATIVE PONDS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

FALLING FILM EVAPORATION
AN INVESTIGATION ON THE DISTILLATION OF BRINE BY VERTICAL TUBE EVAPORATION UTILIZING THE SEPHTON FLASH TUBE (VORTEX TUBE) PROCESS,
W70-04665 03A

SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
W70-04677 03A

FALLOUT
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

FALLOWING
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

FALSE SET
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

FARM PONDS
SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
W70-05025 02J

FARM SIZE
SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

FARM WASTES
AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

FARMS
SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

FAULTS(ELECTRICAL)
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

FEDERAL GOVERNMENT
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

FEEDWATER HEATING
OPTIMUM BRINE HEATER OUTLET TEMPERATURE IN SEA WATER CONVERSION EVAPORATORS.
W70-04955 03A

FEEDWATER TREATMENT
DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
W70-04668 03A

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
W70-04669 03A

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

CONTINUOUS COUNTER-CURRENT ION EXCHANGE REMOVAL OF CALCIUM FROM SEA WATER TO PREVENT SCALING OF DISTILLATION EQUIPMENT.
W70-04953 03A

FERMENTATION
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

FERROUS COMPOUNDS
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

FICK'S LAWS OF DIFFUSION
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

FILMS
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

FILM-FLOW BIOLOGICAL REACTOR
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

FILTRATION
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

FINISHING WASTES
EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
W70-04588 05D

FJORDS
CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
W70-05003 02L

FLASH CHAMBERS
CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

FLASH EVAPORATION
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
W70-04660 03A

EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

THE EILAT 1,000,000 GPD, MSF, DISTILLATION PLANT OPERATING EXPERIENCE,
W70-04948 03A

DESIGN, OPERATION, AND RESULTS OF THE LARGEST FLASH-TYPE SEAWATER CONVERSION PLANT AND ITS EFFECT ON FUTURE CONVERSION PLANTS.
W70-04950 03A

THE FLOW OF FLASHING WATER IN CONDUITS.
W70-04958 03A

PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

FLOCCULATION
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
W70-04962 05D

FLOCCULATOR
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

FLOOD CONTROL
EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
W70-04571 04A

FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
W70-04750 04A

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

FLOOD DAMAGE
FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.

W70-04713 04A

FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
W70-04738 04A

FLOOD PLAIN STUDIES
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

FLOOD PLAINS
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).
W70-04884 05G

FLOOD ROUTING
ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
W70-04750 04A

FLOOD WAVE SUBSIDENCE
FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
W70-04750 04A

FLOOD WAVES
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

FLOODING
PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

FLOODS
FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
W70-04602 02E

FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.
W70-04713 04A

FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
W70-04738 04A

FLORIDA
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER PROBLEMS).
W70-04881 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
W70-04882 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
W70-04883 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).
W70-04884 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (WELL DRILLING, HARD DETERGENTS, CODIFICATION OF DRAINAGE LAWS).
W70-04885 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).
W70-04886 05G

FLOTATION
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

FLOW AUGMENTATION
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

FLOW CHARACTERISTICS
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

FLOW CONTROL
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

FLOW DISTRIBUTION
A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

FLOW FACTORS
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

FLOW MEASUREMENT
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

FLOW PATTERNS
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

FLUIDIZED CULTURE SYSTEMS
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

FLUMES
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

FORECASTING
FORECASTING MUNICIPAL WATER REQUIREMENTS, VOLUME I - THE MAIN II SYSTEM, VOLUME II - THE MAIN II SYSTEM USER'S MANUAL.
W70-04690 06D

DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

FOREST MANAGEMENT
RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
W70-04717 02C

EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

FORMWORK(CONSTRUCTION)
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

FREEDWATER TREATMENT
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

FREEPORT PLANT
SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
W70-04677 03A

OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
W70-04952 03A

FREEZING
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

FREQUENCY ANALYSIS
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

FUNGICIDES
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

GAMMA PROBES
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

GAMMA RAYS
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

GAS EXCHANGES
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

GAS TRANSFER
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

GAS TURBINES
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

GEOCHEMISTRY

GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

GEOLOGY
GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

GEOMORPHOLOGY
REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
W70-05001 02L

GERMANY
QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

GLACIERS
CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

GLOSSARIES
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

GRANULAR CARBON
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

GRANULAR MATERIALS
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

GRAPHICAL ANALYSIS
STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

GRASSES
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

GREAT BRITAIN
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

GREAT LAKES
MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

WATER SYSTEMS MODELING,
W70-04901 06A

GROUNDWATER
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

BIG BLUE RIVER BASIN.
W70-04603 02E

THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04864 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS GROUNDWATER AND A PROPOSED WATER DIVERSION ACT),
W70-04880 06E

GROUNDWATER BARRIERS
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

GROUNDWATER MOVEMENT
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

GROWTH RATES
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

GUNITE
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

GYPSUM
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

HAWAII
FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.
W70-04713 04A

HEAT EXCHANGERS
ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
W70-04929 08G

HEAT TRANSFER
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
W70-05035 08B

THE EFFECT OF FREE STREAM TURBULENCE ON HEAT TRANSFER RATES,
W70-05036 08B

HEAT AND MASS TRANSFER IN TURBULENT BOUNDARY LAYERS,
W70-05037 08B

ADVANCES IN FREE CONVECTION,
W70-05038 08B

EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
W70-05041 08B

FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
W70-05042 08B

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

HEAT TRANSFER COEFFICIENT
RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
W70-04671 03A

HEAT TRANSFER IMPROVEMENTS
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

HEATER-EVAPORATOR TUBES
TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

HEAVY-WATER/ORGANIC-COOLED REACTORS
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

HELE-SHAW MODELS
DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

HERBICIDES
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

HETEROTROPHY
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

HIERARCHY OF WATER QUALITY
MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

HIGH VOLTAGE
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

HIGH-RATE DIGESTION
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

HIGH-RATE TRICKLING FILTERS
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

HISTORIC FLOOD
FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND,

VIRGINIA,
W70-04602 02E

HISTORY(MEAT PROCESSING WASTES)
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

HORIZONTAL TUBE EVAPORATORS
RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
W70-04671 03A

HUNGARY
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

HURRICANES
FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
W70-04602 02E

MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

HYDRAULIC DESIGN
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

HYDRAULIC GATES
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

HYDRAULIC LOAD EFFECTS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

HYDRAULIC MODELS
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

HYDROELECTRIC POWER
INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

HYDROGEOLOGY
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04858 06E

HYDROGRAPH ANALYSIS
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

HYDROGRAPHY
SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
W70-05003 02L

HYDROLOGIC MODELS
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

HYDROTROILITE
DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

HYPOLIMNION
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

ILLINOIS
PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

IMPACT TESTS
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

IMPACT(RAINFALL)
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

IMPOUNDMENTS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

INDANS
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

INDIA
AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

INDIAN OCEAN
THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

INDIANA
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

W70-04858 06E

W70-04859 06E

W70-04860 06E

W70-04861 06E

W70-04862 06E

W70-04863 06E

W70-04864 06E

W70-04865 06E

W70-04866 06E

W70-04867 06E

W70-04868 06E

W70-04869 06E

INDUSTRIAL WASTES
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
W70-04882 05G

INDUSTRIAL WATER
WATER RESOURCES VALUES,
W70-04762 05D

INFILTRATION
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

INFORMATION RETRIEVAL
VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
W70-04600 7C

INJECTION WELLS
UNDER THE RUG,
W70-04589 05G

PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

GEOLOGICAL SUBSIDENCE,
W70-04908 02F

INPUT-OUTPUT ANALYSIS
OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

INSPECTION
JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

INSTITUTIONS
ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

INSTRUMENTATION
AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

INTERFACES
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

INTERSTATE COMMISSIONS
THE DELAWARE RIVER BASIN COMMISSION, A PROTOTYPE IN RIVER BASIN DEVELOPMENT,
W70-04824 06B

INVESTMENT
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

ION EXCHANGE
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

ION EXCHANGERS
CONTINUOUS COUNTER-CURRENT ION EXCHANGE REMOVAL OF CALCIUM FROM SEA WATER TO PREVENT SCALING OF DISTILLATION EQUIPMENT.
W70-04953 03A

IOWA
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

IRON OXIDES
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

IRON SALTS
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

IRRIGATION
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

GEOLOGICAL SUBSIDENCE,
W70-04908 02F

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
W70-04983 06B

IRRIGATION EFFECTS
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

IRRIGATION PROGRAMS
DESALTING CALIFORNIA,
W70-04583 05G

IRRIGATION SYSTEMS
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
W70-04639 03F

IRRIGATION WATER
AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
W70-04985 03C

ISLANDS
BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

ISRAEL
SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
W70-04613 02L

EXTRA-DEEP PONDS,
W70-04790 05D

FOG IN ISRAEL,
W70-04915 03B

JUDICIAL DECISIONS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04866 06E

JUTLAND PENINSULA
ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

KALE
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

KANSAS
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957 65, A COMPILATION,
W70-04560 02J

GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

KAPLAN TURBINES
30 YEARS OF MAINTENANCE EXPERIENCE WITH LARGE KAPLAN TURBINES,
W70-04646 08C

KINETIC MODELS
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

KINETICS
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

KINETICS(WASTE TREATMENT)
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

LABORATORY DATA EXTRAPOLATIONS
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

LABORATORY TESTS
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

LABORATORY-SCALE STUDIES
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

LAGOONS
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
W70-05016 02L

LAKE BALATON (HUNGARY)
CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

LAKE BASINS
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

LAKE MENDOTA(WIS)
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

LAKE MICHIGAN
STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

TO PREVENT AN UNNATURAL DEATH.
W70-04898 05C

BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

LAKE NASSER
ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

LAKE ONTARIO
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

LAKE STAGES
HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

LAKES
AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
W70-04597 02H

LAKE EUTROPHICATION -- A NATURAL PROCESS,
W70-04721 05C

HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
W70-04757 02H

ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

LAMINAR FLOW
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

LAND FORMING
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

LAND MANAGEMENT
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

LAND RECLAMATION
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

LAND SUBSIDENCE
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ,ORLEANS AREA,
W70-04833 04B

GEOLOGICAL SUBSIDENCE,
W70-04908 02F

LAND USE
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

LANDFILLS
LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

LATERITES
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

LEACHING
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

LEAF TEMPERATURE
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

LEGISLATION
TEXTILE WORKS EFFLUENT TREATMENT,
W70-04831 05D

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

W70-04867 06E

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER PROBLEMS).
W70-04881 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
W70-04883 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).
W70-04884 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).
W70-04886 05G

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
W70-04976 05D

LEGISLATIVE REPORTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

LIME
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

LIME RECOVERY
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

LIME REUSE
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

LIMESTONES
THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

LIMNOLOGY
ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

LINEAR PROGRAMMING
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

LIQUID FILM COEFFICIENT
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

LIQUID LAMINAR JET SYSTEM
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

LITTORAL DRIFT
QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
W70-05011 02L

LIVESTOCK MANURE CHARACTERISTICS
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

LOADING
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

LOCAL GOVERNMENTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04869 06E

LOESS
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

LONGITUDINAL MIXING
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE

PLANTS,
W70-04775 05D

LONGITUDINAL MIXING COEFFICIENTS
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

LONG-TERM ECOLOGICAL CHANGES
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

LOUISIANA
GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

LOW ALLOY STEELS
CORROSION OF MILD STEEL UNDER OPERATING CONDITIONS OF A DISTILLATION DESALTING PLANT.
W70-04949 08G

LOWER SABINE RIVER(TEXAS)
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

LOW-QUALITY WATER TREATMENT
WATER RESOURCES VALUES,
W70-04762 05D

LOW-SOLIDS PRODUCTION
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

LYSIMETERS
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

MACROPHYTES
INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
W70-04818 02H

MAINTENANCE
30 YEARS OF MAINTENANCE EXPERIENCE WITH LARGE KAPLAN TURBINES,
W70-04646 08C

MANAGEMENT
ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

MANGANESE
CHEMISTRY OF MANGANESE IN NATURAL WATERS,
W70-04558 02K

MANGANESE SAMPLING
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

MANNINGS EQUATION
RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
W70-04565 02E

MANURE STABILIZATION POND
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

MARGINAL COSTS
ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
W70-04650 04B

MARINE ENVIRONMENTS
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

MARINE MICROORGANISMS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

MARKOV PROCESSES
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

MASS BALANCE EQUATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

MASS CONCRETE
CONCRETE PERFORMANCE IN YELLOWTAIL DAM, MONTANT--5-YEAR CORE REPORT,
W70-04628 08F

MASS TRANSFER
HEAT AND MASS TRANSFER IN TURBULENT BOUNDARY LAYERS,
W70-05037 08B

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

MASS TRANSFER COEFFICIENTS
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

MASS TRASFER
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

MASSACHUSETTS
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

MATERIALS TESTING
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

MATHEMATICAL MODELS
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

A GENERALIZED PROBABILITY MODEL FOR SEQUENCES OF WET AND DRY DAYS,
W70-04695 02B

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

WATER SYSTEMS MODELING,
W70-04901 06A

THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

MATHEMATICAL STUDIES
ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,

W70-04769 05D

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

MEANDERS
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

MEASUREMENT
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

MEAT PROCESSING INDUSTRY
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

MELTING
SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

MEMBRANE PROCESSES
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

MENARD PRESSUREMETER
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

MENHADEN(GULF)
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

MERCERIZING
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

METABOLIC RATES
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

METALS TESTING
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

METHANE BACTERIA
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

METHODOLOGY
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

MICHAELIS-MENTEN GROWTH MODEL
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

MICHIGAN
SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
W70-04557 02J

MICRONUTRIENTS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

MICROORGANISMS
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

MIDWEST(US)
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

MINERALOGY
THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

MINNESOTA
EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
W70-04810 02H

MISSOURI RIVER BASIN
EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

MIXED AEROBIC-ANAEROBIC SYSTEMS
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

MIXED FLOW PUMPS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

MIXING
OCEANIC MIXING,
W70-04697 02L

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
W70-04716 05B

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

MODEL STUDIES
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

ANALYSIS OF WATERSHED CHANGES,
W70-04728 07C

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

WATER SYSTEMS MODELING,
W70-04901 06A

THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

MODEL TESTS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

MODELS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

MODIFIED ANAEROBIC CONTACT PROCESS
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

MODULAR CONSTRUCTION
ENGINEERING ASPECTS OF A NUCLEAR DESALTING PLANT,
W70-04925 03A

MOISTURE
FOG IN ISRAEL,
W70-04915 03B

MOISTURE CONTENT
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

MOISTURE METERS
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

MOISTURE STRESS
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

MORTALITY
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

MUD FLATS
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

MULTILEVEL PLANTS
STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART 1, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

MULTIPLE AERATION UNITS
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

MULTIPLE EFFECT DISTILLATION
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
W70-04668 03A

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
W70-04669 03A

CONCEPTUAL DESIGN STUDY OF A ONE MILLION GALLON PER DAY MSH DESALINATION PLANT - REPLACEMENT FOR DEMONSTRATION PLANT NO. 2 AT POINT LOMA, SAN DIEGO, CALIFORNIA.
W70-04674 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

THE OPTIMAL DESIGN OF DESALINATION SYSTEMS.
W70-04957 03A

MULTIPLE-PURPOSE RESERVOIRS
THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

MULTISTAGE FLASH DISTILLATION
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
W70-04672 03A

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

CONCEPTUAL DESIGN STUDY OF A 1-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW,
W70-04939 03A

CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

THE EILAT 1,000,000 GPD, MSF, DISTILLATION PLANT OPERATING EXPERIENCE,
W70-04948 03A

STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART 1, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

MUNICIPAL WATER
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

FORECASTING MUNICIPAL WATER REQUIREMENTS, VOLUME I - THE MAIN II SYSTEM, VOLUME II - THE MAIN II SYSTEM USER'S MANUAL.
W70-04690 06D

MAIN C COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SYSTEM DOCUMENTATION.
W70-04691 06D

MAIN I A SYSTEM OF COMPUTERIZED MODELS FOR CALCULATING AND EVALUATING MUNICIPAL WATER REQUIREMENTS -- ADDENDUM TO FINAL REPORT.
W70-04692 06D

WATER RESOURCES VALUES,
W70-04762 05D

NATIONAL MULTI-AGENCY OIL AND HAZARDOUS MATERIALS CONTINGENCY PLAN
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

NATURAL AERATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

NATURAL FLOW DOCTRINE
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04859 06E

NATURAL RESOURCES
ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

NATURAL STREAMS
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

NAVIGABILITY TESTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04861 06E

NAVIGABLE RIVERS
WATER RIGHTS IN TENNESSEE,
W70-04874 06E

NAVIGABLE WATERS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04860 06E

W70-04861 06E

NAVIGATION
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04866 06E

NEBRASKA
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

BIG BLUE RIVER BASIN.
W70-04603 02E

THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

NET RADIATION
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

NETHERLANDS
THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

NEW HAMPSHIRE
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

NEW JERSEY
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

NEW ORLEANS

LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

NEW YORK
FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

NILE RIVER
ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

NITRATES
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

NITRIFICATION
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

NITROGEN
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

NITROGEN COMPOUNDS
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

NITROGEN INORGANIC COMPOUNDS
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

NITROGEN REMOVAL
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

NON-DESTRUCTIVE TESTS
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

NON-NAVIGABLE WATERS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04860 06E

W70-04861 06E

NON-STRUCTURAL ALTERNATIVES
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

NORTH SEA
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

NORTHWEST TERRITORIES
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

NORWEGIAN FJORDS
SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
W70-05003 02L

NUCLEAR DENSITY METERS
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

NUCLEAR EXPLOSIONS
HYDRAULIC TESTING AND SAMPLING OF USBR-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

NUCLEAR MOISTURE
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

NUMERICAL ANALYSIS
EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

NUTRIENT FLOWS
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

NUTRIENT INTERACTIONS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

NUTRIENT SOURCES
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

NUTRIENT TYPES
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

NUTRIENT YIELDS
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

NUTRIENTS
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
W70-04993 02L

OCEAN CIRCULATION
A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

OCEAN CURRENTS
OCEANIC MIXING,
W70-04697 02L

A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

OCEAN WAVES
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

ANALYSIS OF WAVE FORCE DATA,
W70-04700 08B

METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

OCEANOGRAPHY
VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
W70-04600 7C

OCEANS
OCEANIC MIXING,
W70-04697 02L

ODOR
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

ODORS
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

OFFSHORE PLATFORMS
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

OIL FIELDS
GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

OIL POLLUTION

OIL TAGGING SYSTEM STUDY, SUMMARY.
W70-04655 05A

OIL RESERVOIRS
GEOLOGICAL SUBSIDENCE,
W70-04908 02F

OIL SAMPLING
OIL SAMPLING TECHNIQUES (A PROGRESS REPORT).
W70-04654 05A

OIL SEPARATOR
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

OIL SHALE
HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

OIL TAGGING
OIL TAGGING SYSTEM STUDY, SUMMARY.
W70-04655 05A

OKLAHOMA
SPRINGS IN THE OZARK REGION, NORTHEASTERN OKLAHOMA,
W70-04594 02F

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

ON-SCENE COMMANDER
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

OPEN CHANNEL FLOW
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

OPERATING EXPERIENCE
OPERATING EXPERIENCE AT THE MULTI-STAGE FLASH DEMONSTRATION PLANT, POINT LOMA, CALIFORNIA,
W70-04679 03A

TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

THE EILAT 1,000,000 GPD, MSF, DISTILLATION PLANT OPERATING EXPERIENCE,
W70-04948 03A

OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
W70-04952 03A

OPERATIONS
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

OPTIMIZATION
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

ORCHARDS
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

OREGON
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

ORGANIC CARBON
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

ORGANIC LOAD EFFECTS
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

ORGANIC LOADING
NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

ORGANIC NITROGEN
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

ORGANIC SOLUTES
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

OVERALL TRANSFER COEFFICIENT
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

OVERDRAFT
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

OVERLYING PROPRIETOR
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04864 06E

OWNERSHIP OF BEDS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04861 06E

W70-04862 06E

WATER RIGHTS IN TENNESSEE,
W70-04874 06E

OXIDATION
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

OXYGEN
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,
W70-04722 02K

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

OXYGEN ANALYSIS
TESTS OF DEAERATOR AT THE FREEPORT SEAWATER DESALTING PLANT AND EVALUATION OF DISSOLVED GAS ANALYSIS.
W70-04954 03A

OXYGEN DEMAND
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

OXYGEN PROFILE EQUATIONS
BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

OXYGEN TRANSFER EFFICIENCY
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

OXYGENATION
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

PACIFIC OCEAN
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

PALEOCLIMATOLOGY
AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
W70-04597 02H

PALEOLIMNOLOGY
HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

PARAMETRIC STUDIES
COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE. DESALTING DISTILLATION PLANTS,
W70-04947 03A

PARTICLE SHAPE
A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

PASTURE MANAGEMENT
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

PATH OF POLLUTANTS
EARTH, AIR, WATER,
W70-04585 05B

LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

PENETROMETERS
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

PERCOLATING WATER
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04864 06E

PERCOLATION
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

PERMAFROST
SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

PERMANGANATE VALUE
CHEMICAL NATURE OF EFFLUENTS FROM THE TEXTILE, LEATHER, AND PAPER INDUSTRIES,
W70-04969 05A

PERSISTENCE
EARTH, AIR, WATER,
W70-04585 05B

PERSISTENCE OF BACTERIA
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

PERSONNEL MANAGEMENT
APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

PESTICIDE DRIFT
EARTH, AIR, WATER,
W70-04585 05B

PESTICIDES
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

PHOSPHOROUS COMPOUNDS
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

PHOSPHORUS
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

PHOSPHORUS COMPOUNDS
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
W70-04962 05D

PHOSPHORUS REMOVAL
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

PHOTOCATALYSTS
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

PHOTOGRAMMETRY
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

PHOTOGRAPHY
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

PHOTOINTERPRETATION
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

PHOTOLYSIS
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

PHOTOSYNTHESIS
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

PHOTOSYNTHETIC OXYGEN
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

PHYSICAL EXCHANGE
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

PHYSICAL LIMNOLOGY
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

PHYSICAL PROPERTIES
SOME PHYSICAL PROPERTIES OF ALPINE SNOW,
W70-04739 02C

PHYSICOCHEMICAL PROPERTIES
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

PHYTOPLANKTON
INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
W70-04818 02H

PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
W70-04855 02H

PILOT PLANT
TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

PILOT PLANT OPERATIONS
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

OPERATING EXPERIENCES AT THE OSW COAST TEST FACILITY, WRIGHTSVILLE BEACH, NORTH CAROLINA,
W70-04942 03A

PILOT PLANTS
PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

PILOT-PLANT STUDIES
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

PIPELINES
SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

PIT RECHARGE
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

PITTING(CORROSION)
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

PLANKTON
THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
W70-04809 02H

PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

PLANKTON SAMPLER
VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

PLANNING
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04544 06A

THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,

W70-04847 06B

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

THE WATER SITUATION,
W70-04914 03B

DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

PLANNING OBJECTIVES
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

PLANT DYNAMICS
DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

PLANT POPULATIONS
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

PLASTIC-BOX AERATOR
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

PLAYAS
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

PLEISTOCENE EPOCH
HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

POINT LOMA PLANT
OPERATING EXPERIENCE AT THE MULTI-STAGE FLASH DEMONSTRATION PLANT, POINT LOMA, CALIFORNIA,
W70-04679 03A

POLAND
DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

POLICY
WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

POLICY MAKING
BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

POLLUTION ABATEMENT
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

POLYVINYL CHLORIDE
PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
W70-04797 05D

POND APPEARANCE AND LOCATION
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

POND LOADING RATES
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

PONDS
BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

EXTRA-DEEP PONDS,
W70-04790 05D

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

PORTLAND CEMENTS
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

POST-PRECIPITATION
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

POTASSIUM COMPOUNDS
NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

POWER SYSTEM OPERATION
DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

POWER SYSTEM OPERATIONS
INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

PRAIRIE PROVINCES
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

PRECAST CONCRETE
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

PRECIPITATION
SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
W70-04962 05D

PRECIPITATION INTENSITY
EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

PRECIPITATION UNIT
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

PRECIPITATION(ATMOSPHERIC)
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

PREEMERGENTS
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

PRESCRIPTIVE RIGHTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04865 06E

PRE-TREATMENT(WASTES)
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

PRIOR APPROPRIATION
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04860 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
W70-04879 06E

PROBABILITY
QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

PROBABILISTIC RESERVOIR DESIGN,

PRO-REA

W70-05031 04A

PRODUCTIVITY
AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

PROGRAMS(COMPUTERS)
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

PROJECT PLANNING
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

PROPELLER PUMPS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

PROVENANCE
THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

ORIGIN OF SEDIMENTS IN ESTUARIES,
W70-05013 02L

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

PUBLIC BENEFITS
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

PUBLIC INVESTMENT DECISION MODEL
ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

PUBLIC RIGHTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04862 06E

W70-04866 06E

PUBLIC UTILITIES
UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

PUBLICATIONS
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

PULP AND PAPER INDUSTRY
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

PULSE VELOCITY TESTS
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

PUMPED CONCRETE
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

PUMPING
GEOLOGICAL SUBSIDENCE,
W70-04908 02F

SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

PUMPS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

QUATERNARY PERIOD
EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
W70-05000 02L

QUEENSLAND
AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

RADAR
SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

RADIATION
RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
W70-05035 08B

RADIATION FOG
FOG IN ISRAEL,
W70-04915 03B

RADIOACTIVE WASTES
STATEMENT OF CONCERN,
W70-04584 05B

RADIOCARBON BIOASSAY
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

RADIOISOTOPES
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

RAINDROP CRATERS(WATER)
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

RAINFALL
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

A NOTE ON AREAL RAINFALL DEFINITION,
W70-04719 02B

RAINFALL INTENSITY
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

RAINFALL-RUNOFF RELATIONSHIPS
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
W70-04581 02A

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON NUKEWATER CREEK, TEXAS,
W70-04726 04C

ANALYSIS OF WATERSHED CHANGES,
W70-04728 07C

POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

RANGE MANAGEMENT
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

RAPPAHANNOCK ESTUARY
SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

RATE OF COLLISION
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

RAYON
THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

REACTION KINETICS
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

REACTOR DYNAMICS
AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

REAERATION
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

REASONABLE USE
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04859 06E

RECHARGE
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

RECHARGE WELLS
ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
W70-04608 04B

RECIRCULATION FILTERS
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

RECLAIMED WATER
ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

RECREATION
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

RECREATION BENEFIT ESTIMATING
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

RED SEA
FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
W70-04570 02K

REDUCTION(CHEMICAL)
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

REFLECTIVITY
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

REGIONAL ANALYSIS
CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

REGIONAL SYSTEMS APPROACH
WATER RESOURCES VALUES,
W70-04762 05D

REGRESSION ANALYSIS
EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

REGULATION
STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

REMOTE SENSING
SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

REMOVAL EFFICIENCIES
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

REMOVAL FROM FEEDWATER
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

REPULSION(LEGAL ASPECTS)
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04863 06E

RESEARCH AND DEVELOPMENT
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

RESEARCH FACILITIES
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

RESEARCH NEEDS
CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

RESERVOIR DESIGN
STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
W70-05025 02J

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

PROBABILISTIC RESERVOIR DESIGN,
W70-05031 04A

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

RESERVOIR DESIGN DATA
HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

RESERVOIR OPERATION
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

RESERVOIR SILTING
DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
W70-05025 02J

RESERVOIR STORAGE
STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR

EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

RESERVOIR YIELD
DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
W70-05029 04A

DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

RESERVOIRS
URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE MASSER.
W70-04756 02B

THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

. . . THE ROMAN DAMS OF SUBIACO,
W70-04980 08A

BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
W70-05022 04A

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
W70-05023 02E

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05034 02E

RESIDENTIAL LOCATION DESIROUS
WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

RESIDUAL SOILS
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

RESONANCE FREQUENCY METHOD
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

RESOURCE DEVELOPMENT
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION-VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04827 06B

RESOURCE REUTILIZATION
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

RESPIRATION
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

RESPONSE FUNCTION
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

RETURN FLOW
DESALTING CALIFORNIA,
W70-04583 05G

REVERSE OSMOSIS
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

REVIEWS
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

OCEANIC MIXING,
W70-04697 02L

FLASH DESALINATION PLANT - THE RESULTS OF THE FIRST TEN YEARS OF DEVELOPMENT AND FIELD PROVING,
W70-04926 03A

DESIGN, OPERATION, AND RESULTS OF THE LARGEST FLASH-TYPE SEAWATER CONVERSION PLANT AND ITS EFFECT ON FUTURE CONVERSION PLANTS.
W70-04950 03A

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

RIDDANCE(LEGAL ASPECTS)
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04863 06E

RIGIDITY MODULUS
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

RIPARIAN LAND
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04858 06E

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04872 06E

RIPARIAN RIGHTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04859 06E

W70-04862 06E

W70-04867 06E

GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

W70-04872 06E

W70-04873 06E

WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
W70-04875 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
W70-04878 06E

RISKS
PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

RIVER BASIN MANAGEMENT
ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

RIVER BASIN PLANNING
CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

RIVER BASINS
ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

RIVER FLOW
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

RIVERS
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

ROUGHNESS(HYDRAULIC)
RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
W70-04565 02E

ROUTING
EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

RUNNING WATERS
WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
W70-04875 06E

RUNOFF
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

RUNOFF FORECASTING
EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

SAANICH INLET
CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

SAFE YIELD
ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

SAFETY
JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

SALINE BARRIER LINES
REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
W70-04883 05G

SALINE SOILS
A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
W70-04985 03C

SALINE WATER
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
W70-04570 02K

CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

SALINE WATER INTRUSION
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
W70-04613 02L

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FOREIGN MATTER AND SALT WATER INTRUSION IN PUBLIC WATERS).
W70-04883 05G

SALINE WATER-FRESHWATER INTERFACES
ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
W70-04608 04B

FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
W70-04613 02L

SALINITY
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

SALINITY MEASUREMENTS IN ESTUARIES,
W70-04999 02L

SALT BALANCE
SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

SALT MARSH ESTUARY
THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

SALT MARSHES
THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

SALT RIVER PROJECT
ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

SALT TOLERANCE
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

SALTATION
MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

SAMPLING
OIL SAMPLING TECHNIQUES (A PROGRESS REPORT).
W70-04654 05A

VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

SAN JOAQUIN VALLEY
GEOLOGICAL SUBSIDENCE,
W70-04908 02F

SANDS
MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

SARAN-TUBE AERATOR
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

SCALE PREVENTION
CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
W70-04660 03A

DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

CONTINUOUS COUNTER-CURRENT ION EXCHANGE REMOVAL OF CALCIUM FROM SEA WATER TO PREVENT SCALING OF DISTILLATION EQUIPMENT.
W70-04953 03A

SCOURING WASTE
A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

SEA ICE
SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

SEA WATER
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

SEALANT
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

SEASONAL
EXTRA-DEEP PONDS,
W70-04790 05D

SEASONAL AND VERTICAL DISTRIBUTION OF THE ZOOPLANKTON IN THE ASKO AREA (NORTHERN BALTIC PROPER) IN RELATION TO HYDROGRAPHICAL CONDITIONS,
W70-04816 05C

SECONDARY EFFLUENT
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

SECONDARY RECOVERY(OIL)
PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

SEDIMENT DISCHARGE
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957 65, A COMPILATION,
W70-04560 02J

SEDIMENT LOAD
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957

65, A COMPILATION,
W70-04560 02J

TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

SEDIMENT STORAGE
SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

SEDIMENT TRANSPORT
THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
W70-04566 02L

MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
W70-04599 02J

ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
W70-05011 02L

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

SEDIMENTARY STRUCTURES
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

SEDIMENTATION
TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
W70-04976 05D

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
W70-05001 02L

SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
W70-05023 02E

SEDIMENTATION CURVE
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

SEDIMENTATION RATES
RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
W70-05012 02L

SEDIMENTS
THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
W70-05010 02J

RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
W70-05012 02L

ORIGIN OF SEDIMENTS IN ESTUARIES,
W70-05013 02L

SEEDING PROCESSES
ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
W70-04672 03A

TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

SEEDLINGS
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

SELENIUM
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

SELF-PURIFICATION
THE PROBLEM OF WASTE WATER TREATMENT,
W70-04970 05D

SEMIARID CLIMATES
EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

SEMI-ARID CLIMATES
FOG IN ISRAEL,
W70-04915 03B

SENATE SUBCOMMITTEE ON ECONOMY IN GOVERNMENT
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04828 06B

SEPARATION TECHNIQUES
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

SETTLING TANKS
DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

SETTLING VELOCITY
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

SEWAGE
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

SEWAGE DISPOSAL
THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
W70-04648 05D

SEWAGE TREATMENT
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

WASTE STABILIZATION POND PRACTICES IN CANADA,

W70-04789 05D

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

SEWERS
PROBLEMS OF EFFLUENT DISPOSAL,
W70-04963 05D

DEVELOPMENTS AND EQUIPMENT IN EFFLUENT TREATMENT,
W70-04977 05D

SHEAR FLOW
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

SHEAR STRENGTH
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

SHORE PROTECTION
SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

SHRIMP
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

SIEVE ANALYSIS
A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

SIEVES
A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

SIMULATED RAINFALL
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

SIMULATION
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

SIMULATION ANALYSIS
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

ANALYSIS OF WATERSHED CHANGES,
W70-04728 07C

SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

PROBABILISTIC RESERVOIR DESIGN,
W70-05031 04A

SINGLE-PURPOSE PLANT
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

SINGLE-PURPOSE PLANT ECONOMICS
COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
W70-04675 03A

SLASHING WASTES
WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

SLOPE STABILITY
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

SLUDGE
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

SLUDGE DEWATERABILITY
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

SLUDGE DISPOSAL
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

SLUDGE LOADS
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

SLUDGE PRODUCTION
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

SLUDGE SETTLEABILITY
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

SLUDGE TREATMENT
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

SLUDGES
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

SLUDGE-BLANKET CLARIFIERS
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

SLUDGE-LOSS FACTOR
RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BASE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

SMALL WATERSHEDS
EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
W70-04571 04A

FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04825 06B

EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

SNAKE CREEK PUMPING PLANT(N DAK)
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

SNAPBEANS
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

SNOW
FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

SOME PHYSICAL PROPERTIES OF ALPINE SNOW,
W70-04739 02C

SNOW COVER
RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

SNOW DENSITY
RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

SNOWFIELDS
UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

SNOWPACKS
RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
W70-04717 02C

SOCIAL NEEDS
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

SOCIAL SCIENCES
CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

SODIUM NITRATES
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

SOIL
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

SOIL CHEMICAL PROPERTIES
A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER

IRRIGATION,
W70-04985 03C

SOIL CHEMISTRY
IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

SOIL CONSERVATION
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

SOIL DENSITY
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

SOIL EROSION
SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
W70-04557 02J

SOIL FORMATION
THE PHYSICS AND MECHANICS OF SOIL,
W70-04631 08D

SOIL MECHANICS
THE PHYSICS AND MECHANICS OF SOIL,
W70-04631 08D

SOIL MOISTURE
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

SOIL PHYSICAL PROPERTIES
A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
W70-04985 03C

SOIL PHYSICS
THE PHYSICS AND MECHANICS OF SOIL,
W70-04631 08D

SOIL PROPERTIES
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

SOIL SURFACES
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

SOIL SURVEYS
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

W70-04630 08D

SOIL TESTS
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

SOIL WATER
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

SOIL WATER MOVEMENT
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

SOIL WATER RESERVES
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

SOIL-WATER-PLANT RELATIONSHIPS
CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

SOLAR RADIATION
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

SOLID RETENTION TIME(SRT)
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

SOLID WASTES
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

SOLIDS CONTACT PROCESSES
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

SOLUBLE WASTES
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

SOLUTES
IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

SOLVENT SCOURING
CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
W70-04960 05D

SONIC-PULSE TEST
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

SOUND WAVES
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

SOURCES AND SINKS OF OXYGEN
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

SOUTH AUSTRALIA
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

SOUTH CAROLINA
FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
W70-04738 04A

SOUTHWEST UNITED STATES
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

SOUTHWEST(US)
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

SPECIES DIVERSITY
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

SPECIES-DIVERSITY INDEX
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

SPILLWAYS
CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

SPRAY IRRIGATION
DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

SPRAYED CONCRETE
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

SPRINGS
SPRINGS IN THE OZARK REGION, NORTHEASTERN OKLAHOMA,
W70-04594 02F

STABILITY
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

STABILIZATION
BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

EXTRA-DEEP PONDS,
W70-04790 05D

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

STABILIZATION BASINS OR LAGOONS
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

STABLE ISOTOPES
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

STAGE-DISCHARGE RELATIONS
ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

STAGNANT WATER
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

STAINLESS STEEL
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

STARCH
ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
W70-04807 05D

STARCH WASTES
TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

STARCH-GLUTEN WASTE
PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

STARCH-GLUTEN WASTE TREATMENT
PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

STATE GOVERNMENTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04868 06E

W70-04869 06E

STATISTICAL METHODS
TRANSFERRING STREAMFLOW CHARACTERISTICS,
W70-04554 02E

ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
W70-04757 02H

GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
W70-05029 04A

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

STATISTICAL MODELS
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

STEAM FLOW
THE FLOW OF FLASHING WATER IN CONDUITS.
W70-04958 03A

STOCK WATER
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

STOCKING
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

STORAGE CAPACITY
RELATIONSHIP BETWEEN STORAGE CAPACITY AND LOAD FACTOR OF A DESALINATION PLANT,
W70-04905 03A

STORM RUNOFF
URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

STORMS
THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
W70-04566 02L

STRAIT OF GEORGIA
SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

STRAIT OF JUAN DE FUCA
SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

STRATIFICATION
URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

STREAM AERATION
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

STREAM POLLUTION
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

STREAM QUALITY
BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

STREAMFLOW
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

STREAMFLOW FORECASTING
TRANSFERRING STREAMFLOW CHARACTERISTICS,
W70-04554 02E

ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
W70-05019 04A

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

STREAMS
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957 65, A COMPILATION,
W70-04560 02J

ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

STRESS INDEX
AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

STRONTIUM RADIOISOTOPES
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

STRUCTURAL ANALYSIS
STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,

STR-TER
W70-04643 08A

RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

STUDIES
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

SUBSTITUTE CHEMICALS
POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

SUBSURFACE WATERS
WATER RIGHTS IN TENNESSEE,
W70-04874 06E

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
W70-04876 06E

SULFATES
CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

SULFIDES
EXTRA-DEEP PONDS,
W70-04790 05D

DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

SULFUR
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

SULPHUR DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

SURFACE ACTIVE AGENTS
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

SURFACE AERATION
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

SURFACE RUNOFF
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04863 06E

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
W70-04876 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS GROUNDWATER AND A PROPOSED WATER DIVERSION ACT),
W70-04880 06E

SURFACE WATERS
RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

BIG BLUE RIVER BASIN.
W70-04603 02E

CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,
W70-04722 02K

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
W70-04875 06E

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
W70-04876 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
W70-04878 06E

SURFACES
STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

SURFACE-GROUNDWATER RELATIONSHIPS
PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
W70-04581 02A

SURFACTANTS
NEW CONCEPTS IN OXIGEN TRANSFER AND AERATION,
W70-04777 05D

MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

SURVEILLANCE
OIL TAGGING SYSTEM STUDY, SUMMARY.
W70-04655 05A

SURVEYS
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
W70-04757 02H

ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

SUSPENDED LOAD
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

SUSPENDED SOLIDS
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

SUSPENSION INSULATORS
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

SUSQUEHANNA DRAINAGE BASIN
CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

SUSQUEHANNA RIVER BASIN
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

SYNOPTIC ANALYSIS
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

SYNTHETIC HYDROLOGY
EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

SYSTEM CONSTANTS AND COEFFICIENTS
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

SYSTEM KINETICS
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

SYSTEMS ANALYSIS
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

SYSTEMS ENGINEERING
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

TAGGING
OIL TAGGING SYSTEM STUDY, SUMMARY.
W70-04655 05A

TEMPERATURE
NEW CONCEPTS IN OXIGEN TRANSFER AND AERATION,
W70-04777 05D

LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
W70-05035 08B

TENNESSEE
WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
W70-04875 06E

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
W70-04876 06E

TERTIARY TREATMENT
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,

W70-04547 05D

APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

TEST PROCEDURES
CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

TEST RESULTS
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

TESTING
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

TESTING EQUIPMENT
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

TEXAS
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

TEXAS COAST
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

TEXAS WATER PLAN
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

TEXTILE FINISHING PLANT
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

TEXTILE MILL WASTES
SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
W70-04637 05D

PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
W70-04797 05D

THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
W70-04962 05D

CHEMICAL NATURE OF EFFLUENTS FROM THE TEXTILE, LEATHER, AND PAPER INDUSTRIES,
W70-04969 05A

SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

APPLICATION OF CHLORINE AND TREATMENT OF TEXTILES WASTES,
W70-04974 05D

PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
W70-04975 05D

TEXTILE WASTES
TREATMENT OF INDUSTRIAL WASTE WATERS IN THE UNITED STATES,
W70-04895 05D

THEORETICAL ANALYSIS
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

THERMAL BAR
PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
W70-04902 05C

THERMAL GRADIENT
EXTRA-DEEP PONDS,
W70-04790 05D

THERMAL POLLUTION
STATEMENT OF CONCERN,
W70-04584 05B

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
W70-04716 05B

THERMAL PROTECTION
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

THERMAL STRATIFICATION
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

EXTRA-DEEP PONDS,
W70-04790 05D

THERMOCLINE
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

THERMO-DRI-PROCESS
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

TIDAL WATERS
WHAT IS AN ESTUARY PHYSICAL VIEW POINT,
W70-05014 02L

TITANIUM
CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
W70-04667 08G

TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

TITANIUM ALLOYS
CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
W70-04667 08G

TOLERANCE LEVELS
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

TORSIONAL RESONANT FREQUENCY
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

TOTAL COUNT METHOD
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

TOXICITY
I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

TRACE ELEMENTS
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

TRACERS
USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,
W70-04551 07B

DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

TRACKING TECHNIQUES
USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,

W70-04551 07B

TRANSFER
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

TRANSMISSION LINES
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

TRANSPIRATION
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

TREATMENT
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

TREATMENT FACILITIES
TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

TRICKLING FILTERS
CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
W70-04975 05D

TRITIUM
A ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM BY ELECTROLYTIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING,
W70-04735 02K

TUBA CITY
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

TUBE BUNDLE DESIGN
PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

TUBING(METAL)
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

TUNNEL CONSTRUCTION
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

TUNNEL LININGS
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

TUNNEL SUPPORTS
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

TURBIDITY
I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

TURBINE AERATION
RIVER POLLUTION IN INDUSTRIAL AREAS AN INSOLUABLE PROBLEM,
W70-04587 05D

TURBULENCE
THE EFFECT OF FREE STREAM TURBULENCE ON HEAT TRANSFER RATES,
W70-05036 08B

TURBULENT FLOW
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

TURNIPS
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

TWISTED TAPES
AN INVESTIGATION ON THE DISTILLATION OF BRINE BY VERTICAL TUBE EVAPORATION UTILIZING THE SEPHTON FLASH TUBE (VORTEX TUBE) PROCESS,
W70-04665 03A

ULTIMATE STRENGTH
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

ULTIMATE STRENGTH DESIGN
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

ULTRASONIC IMPULSE METHOD
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

ULTRASONICS
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

UNIT HYDROGRAPHS
EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

URBAN ENVIRONMENT
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

URBAN SPRAWL
URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

URBANIZATION
SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
W70-04557 02J

THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

USSR
FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
W70-05019 04A

HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

UTAH
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

VACUUM CHAMBER
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

VACUUM FREEZING
VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

VALUE
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

WATER RESOURCES VALUES,
W70-04762 05D

VAPOR COMPRESSION EVAPORATION
A NEW RIVAL FOR FLASH DISTILLATION,
W70-04932 03A

VAPOR RELEASE RATE
THE FLOW OF FLASHING WATER IN CONDUITS.
W70-04958 03A

VAT DYES
FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

VEGETABLE CROPS
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

VEGETATION
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

VEGETATION EFFECTS
RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
W70-04717 02C

VEGETATION MANIPULATION
MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

VELOCITY GRADIENT
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

VELOCITY METHOD
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

VERTICAL DISTRIBUTION
VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

VERTICAL MIGRATION
VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

VERTICAL TUBE EVAPORATORS
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
W70-04668 03A

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
W70-04669 03A

ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
W70-04672 03A

SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
W70-04677 03A

DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
W70-04952 03A

VIRGINIA
FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
W70-04602 02E

VIRUSES
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

VISCOSE RAYON
DEVELOPMENTS AND EQUIPMENT IN EFFLUENT TREATMENT,
W70-04977 05D

VITAMINS
DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

VORTICES
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

WASTE CONSERVATION
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

WASTE DISPOSAL
UNDER THE RUG,
W70-04589 05G

UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

WASTE DISPOSAL WELLS
UNDER THE RUG,
W70-04589 05G

WASTE HEAT BOILERS
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

WASTE STABILIZATION PONDS
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

WASTE TREATMENT
WATER RESOURCES VALUES,
W70-04762 05D

INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

II. THE FEASIBILITY OF TREATING TEXTILE WASTES IN CONNECTION WITH DOMESTIC SEWAGE,
W70-04851 05D

WASTE WATER DISPOSAL
TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

WASTE WATER TREATMENT
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC SEWAGE,
W70-04795 05A

OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

TREATMENT OF INDUSTRIAL WASTE WATERS IN THE UNITED STATES,
W70-04895 05D

WASTEWATER CHARACTERISTICS
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

WASTEWATER EFFLUENT
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

WASTEWATER TREATMENT
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

WASTEWATERS

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

WATER ALLOCATION(POLICY)
PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
W70-04877 06E

THE WATER SITUATION,
W70-04914 03B

WATER ANALYSIS
A ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM BY ELECTROLYTIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING,
W70-04735 02K

WATER CHEMISTRY
CHEMISTRY OF MANGANESE IN NATURAL WATERS,
W70-04558 02K

THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
W70-04615 02K

SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

PRODUCTIVITY OF PHITOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
W70-04855 02H

ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

WATER CIRCULATION
SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

CIRCULATION AND DIFFUSION,
W70-05004 02L

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

WATER CONSERVATION
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

MAIN C COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SYSTEM DOCUMENTATION.
W70-04691 06D

WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

IV. WASTE WATER CONTROL AND WATER CONSERVATION,
W70-04853 05D

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
W70-04877 06E

MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

WATER CONTENT
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

WATER COSTS ESTIMATE
COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
W70-04675 03A

A NEW RIVAL FOR FLASH DISTILLATION,
W70-04932 03A

THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

WATER DEMAND
PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
W70-04877 06E

WATER LAW
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

WATER LEVEL FLUCTUATIONS
GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

W70-04873 06E

WATER LEVEL MAINTENANCE
GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

WATER LEVELS
CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

WATER MANAGEMENT
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

WATER MANAGEMENT(APPLIED)
THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
W70-05019 04A

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

PROBABILISTIC RESERVOIR DESIGN,
W70-05031 04A

APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

WATER MEASUREMENTS
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

WATER POLICY
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

WATER POLLUTION
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER PROBLEMS).
W70-04881 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).
W70-04886 05G

NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

WATER POLLUTION CONTROL
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

TEXTILE WORKS EFFLUENT TREATMENT,
W70-04831 05D

WASTE WATER CONTROL SYMPOSIUM.
W70-04849 05D

OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

WATER POLLUTION EFFECTS
STATEMENT OF CONCERN,
W70-04584 05B

WATER POLLUTION SOURCES
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC

CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

STATEMENT OF CONCERN,
W70-04584 05B

EARTH, AIR, WATER,
W70-04585 05B

LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (INDUSTRIAL AND DOMESTIC POLLUTION).
W70-04882 05G

POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

WATER PROPERTIES
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

WATER QUALITY
TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,
W70-04722 02K

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (FLORIDA'S WATER PROBLEMS).
W70-04881 05G

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES (PROPOSED STATUTES).
W70-04886 05G

THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

WATER QUALITY CONTROL
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

WATER REQUIREMENTS
FORECASTING MUNICIPAL WATER REQUIREMENTS, VOLUME I - THE MAIN II SYSTEM, VOLUME II - THE MAIN II SYSTEM USER'S MANUAL.
W70-04690 06D

MAIN I A SYSTEM OF COMPUTERIZED MODELS FOR CALCULATING AND EVALUATING MUNICIPAL WATER REQUIREMENTS -- ADDENDUM TO FINAL REPORT.
W70-04692 06D

WATER RESOURCES
AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

THE WATER SITUATION,
W70-04914 03B

INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

WATER RESOURCES DEVELOPMENT
BIG BLUE RIVER BASIN.
W70-04603 02E

REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04868 06E

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

WATER RESOURCES INFORMATION
SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

WATER RESOURCES PLANNING ACT
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

WATER RESOURCES RESEARCH ACT
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

WATER REUSE
ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

ECONOMICS OF RECLAIMED WATER IN DYEWORKS.
W70-04946 05D

WATER RIGHTS
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

W70-04865 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
W70-04878 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
W70-04879 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS GROUNDWATER AND A PROPOSED WATER DIVERSION ACT),
W70-04880 06E

WATER SPREADING
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

WATER STORAGE
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

REPORT OF THE SELECT COMMITTEE ON WATER RESOURCES, (FLOOD PLAIN AREAS AND WATER STORAGE LANDS).
W70-04884 05G

THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05034 02E

WATER SUPPLY
URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

THE WATER SITUATION,
W70-04914 03B

WATER TEMPERATURE
PREDICTING THE EFFECT OF CLEARCUTTING ON STREAM TEMPERATURE,
W70-04556 04C

A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

WATER TRANSFER
THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

WATER TREATMENT
CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

WATER UTILIZATION
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

QUANTITATIVE ANALYSIS OF RESIDENTIAL WATER-USE PATTERNS IN MAYAGUEZ, PUERTO RICO,
W70-04830 06D

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

WATER WELLS
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

WATER YIELD IMPROVEMENT
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

WATERCOURSES(LEGAL)
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04858 06E

WATERSHED MANAGEMENT
EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

WATERSHEDS(BASINS)
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

WAVES(WATER)
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

ANALYSIS OF WAVE FORCE DATA,
W70-04700 08B

WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
W70-05022 04A

WEATHER FORECASTING
A GENERALIZED PROBABILITY MODEL FOR SEQUENCES OF WET AND DRY DAYS,
W70-04695 02B

FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

WEEDS
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

WELLS
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

WESTERN STATES WATER COUNCIL
THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

WESTERN U
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

WHITNEY POINT RESERVOIR
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

WINDS
FOG IN ISRAEL,
W70-04915 03B

WISCONSIN
PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
W70-04877 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
W70-04878 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
W70-04879 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS GROUNDWATER AND A PROPOSED WATER DIVERSION ACT),
W70-04880 06E

WITHDRAWAL
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

WOOD PRESERVATIVES
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

WOOD-POLE TRANSM LINES
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

WOOD-WASTES
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

WOOL
TREATMENT OF WOOL WASTES,
W70-04626 05D

THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
W70-04967 05D

WOOL DYEING WASTES
CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

WOOL GREASE
TREATMENT OF WOOL WASTES,
W70-04626 05D

NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

DEVELOPMENTS AND EQUIPMENT IN EFFLUENT TREATMENT,
W70-04977 05D

WOOL GREASE RECOVERY
A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

WOOL SCOURING
TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,

W70-04897 05D

WOOL-SCOURING WASTES
TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
W70-04967 05D

WRIGHTSVILLE BEACH PLANT
CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

OPERATING EXPERIENCES AT THE OSW COAST TEST FACILITY, WRIGHTSVILLE BEACH, NORTH CAROLINA,
W70-04942 03A

WYOMING
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

ZEOLITES
AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

ZONING
SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

ZOOLGOEA RAMIGERA
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

ZOOPLANKTON
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

SEASONAL AND VERTICAL DISTRIBUTION OF THE ZOOPLANKTON IN THE ASKO AREA (NORTHERN BALTIC PROPER) IN RELATION TO HYDROGRAPHICAL CONDITIONS,
W70-04816 05C

PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
W70-04855 02H

'BALAS' ALGORITHM
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

'HOMOGENEOUS DIFFUSION MODEL'
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

'PORE DIFFUSION MODEL'
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

'ZONED UNIFORM TREATMENT'
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

'ZONE-SETTLING'
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

AUTHOR INDEX

AAGAARD, P. M.
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

ABE, K.
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

ACKEFORS, HANS
SEASONAL AND VERTICAL DISTRIBUTION OF THE ZOOPLANKTON IN THE ASKO AREA (NORTHERN BALTIC PROPER) IN RELATION TO HYDROGRAPHICAL CONDITIONS,
W70-04816 05C

ACKERMANN, WILLIAM C.
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

AGARDY, FRANKLIN J.
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

AKERLOW, E. W.
OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
W70-04952 03A

ALBERT, C. D.
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957 65, A COMPILATION,
W70-04560 02J

ALEUCHINSKAYA, Z. V.
HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

ALLEN, PAUL B.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

AMES, L. L.
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

ARMSTRONG, NEAL E.
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

ASFARI, A. F.
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

ASHLEY, EDWARD E.
30 YEARS OF MAINTENANCE EXPERIENCE WITH LARGE KAPLAN TURBINES,
W70-04646 08C

AUSTIN, JOHN H.
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

AXTHELM, D. D.
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

BABCOCK, H. M.
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

BAIRD, RALPH W.
EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

BALAKRISHNAN, S.
NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

BALDAUF, E. J.
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

BALDWIN, JAMES W., JR.
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

BALL, S. J.
DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

BANKS, HARVEY O.
SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

BARKER, SUSAN
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

BARLAGE, W. E., JR.
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

BARNEKOW, RUSSELL G., JR.
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

BARNES, W. L.
OPERATING EXPERIENCES AT THE OSW COAST TEST FACILITY, WRIGHTSVILLE BEACH, NORTH CAROLINA,
W70-04942 03A

BARNHART, EDWIN L.
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

BARTH, E. F.
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

BARTLEY, C. H.
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

BASSILAKIS, C. A.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

BATES, WILLIAM F., JR.
STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

BATTJES, J. A.
QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
W70-05011 02L

BATURIN, G. N.
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

BEARDSLEY, GEORGE F., JR.
AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

BECKMANN, ROBERT B.
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

BECK, ROBERT E.
GOVERNMENTAL REFILLING OF LAKES AND PONDS AND THE ARTIFICIAL MAINTENANCE OF WATER LEVELS MUST JUST COMPENSATION BE PAID TO ABUTTING LANDOWNERS,
W70-04870 06E

W70-04871 06E

W70-04872 06E

W70-04873 06E

BEER, C. E.
EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

BEHN, VAUGHN C.
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

BENDEFY, L.
CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

BEREND, ANDRE
EXTRA-DEEP PONDS,
W70-04790 05D

BERGER, HERBERT F.
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

BERKEL, FCAA VAN
EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

BERNER, ROBERT A.
DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

BERNIER, J.
ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

BERTHOUEX, PAUL M.
PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

BEUSCHER, J. H.
SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

BEYER, JACQUELYN L.
WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

BIGGS, ROBERT B.
THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

BIGLANE, K. E.
NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

BILELLO, MICHAEL A.
RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

BINGHAM, JAY B.
THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

BINGHAM, ROY H.
SPRINGS IN THE OZARK REGION, NORTHEASTERN OKLAHOMA,
W70-04594 02F

BIRD, E. C. F.
REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
W70-05001 02L

BIRKETT, J. D.
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

BIRO, ZS.
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

BISCHOFF, JAMES
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

BITTINGER, M. W.
DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

BLACK, H. H.
TREATMENT OF INDUSTRIAL WASTE WATERS IN THE UNITED STATES,
W70-04895 05D

BOBDAREV, L. G.
HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

BOGOSLOVSKY, B. B.
ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

BOLL, MARTIN W.
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

BOLOTOV, A. A.
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

BOND, GERARD C.
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

BOUSQUET, KENNETH J.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04828 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

BOUWER, HERMAN
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

BOWDEN, GEORGE F.
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

BOWDEN, K. F.
CIRCULATION AND DIFFUSION,
W70-05004 02L

BOYCE, D. E.
A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

BOYER, DENNIS L.
AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

BOYLE, W. C.
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

BRADFORD, ALBERT
UNDER THE RUG,
W70-04589 05G

BRATER, E. F.
EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

BRENNER, R. C.
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

BROCK, T. D.
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

BROECKER, W. S.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

BROWN, GEORGE W.
PREDICTING THE EFFECT OF CLEARCUTTING ON STREAM TEMPERATURE,
W70-04556 04C

BROWN, JERRY
IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

BROWN, PETER
EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
W70-04588 05D

BRUNARSKI, L.
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

BRUUN, P.
USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,
W70-04551 07B

BRYSON, REID
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

BUGLIARELLO, GEORGE
A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

BUKOVSZKY, GY.
STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

BURBANK, NATHAN C., JR.
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

BURCHINAL, JERRY C.
LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

BURFORD, M. G.
POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

BURGES, STEPHEN J.
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04544 06A

BUSCH, A. W.
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

BUSSELL, M. B.
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

BUSWELL, A. M.
TREATMENT OF WOOL WASTES,
W70-04626 05D

ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
W70-04807 05D

BYRNE, JOHN V.
SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

CAIRNS, J. L.
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

CAMPBELL, R. S.
SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

CANHAM, ROBERT A.
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

CARLUCCI, A. F.
DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

CARREKER, J. R.
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

CARRIQUE, C. S.
SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
W70-04637 05D

CARSTENS, M. R.
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

CARTER, H. H.
A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
W70-04716 05B

CASEY, JIM T.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

CASPERS, HUBERT
ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

CESARIO, F. J.
A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

CHAMBERLAIN, N. S.
APPLICATION OF CHLORINE AND TREATMENT OF TEXTILES WASTES,
W70-04974 05D

CHARMONMAN, SRISAKDI
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

CHENG, C. Y.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

CHERNOZUBOV, V. B.
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

CHESNER, L.
SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

CHIPPERFIELD, P. N. J.
PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
W70-04797 05D

CHITTENDEN, M. E., JR.
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

CLABORN, B. J.
APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

CLAPP, N. E.
DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

CLYMO, R. S.
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

COATES, GLENN R.
PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN,
W70-04877 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (RIPARIAN RIGHTS AND SURFACE WATERS),
W70-04878 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DOCTRINE OF PRIOR APPROPRIATION),
W70-04879 06E

PRESENT AND PROPOSED LEGAL CONTROL OF WATER RESOURCES IN WISCONSIN (DIFFUSED SURFACE WATERS GROUNDWATER AND A PROPOSED WATER DIVERSION ACT),
W70-04880 06E

COLBURN, A. P.
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

COLE, J. A.
GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
W70-05029 04A

COLLINGE, V. K.
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

COLLINS, A. GENE
GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

CONCI, GIORGIO
APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

COOKE, W. E.
THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

COPELAND, B. J.
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

CORDES, E. H.
HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

COREY, G. L.
SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

CORTECCI, G.
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

COSKUN, ERDAL
APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

COVER, A. E.
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

COX, WILLIAM M.
STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

CRABTREE, K.
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

CRAWFORD, NORMAN H.
ANALYSIS OF WATERSHED CHANGES,
W70-04728 07C

RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

CULVER, R. H.
PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
W70-04975 05D

CUNGE, J. A.
ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

CURRAN, H. M.
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

CURTISS, D. A.
CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,

W70-04722 02K

CYBERSKI, J.
DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

DANIELS, J. M.
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

DAVIS, STANLEY N.
GEOLOGICAL SUBSIDENCE,
W70-04908 02F

DAYAN, V. H.
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

DE JONG, C. H.
THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

DEAN, KARL C.
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

DEAN, R. B.
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

DEAN, R. G.
WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

DEDRICK, ROBERT L.
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

DEVRIES, RICHARD M.
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

DEWEY, C. F., JR.
EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

DI TORO, DOMINIC M.
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

DICKEY, DONALD W.
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

DICKSON, KENNETH
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

DIETRICH, K. R.
SIMPLIFIED CHEMICAL TREATMENT OF WASTE WATER FROM TEXTILE FACTORIES WITH CLARIFYING, FLOCCULATING, AND PRECIPITATING AGENTS (IN GERMAN),
W70-04962 05D

DOTY, L. F.
CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
W70-04615 02K

DOUILLET, ANDRE
DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

DOVE, R. P.
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

DOWNING, A. L.
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

DOWNING, PAUL B.
THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
W70-04648 05D

DOWNING, R. A.
THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

DROBNY, NEIL L.
WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

DRYMAN, W. R.
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

DUBREUIL, PIERRE
USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05034 02E

DYCK, S.
QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

DYKSTRA, D. I.
SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
W70-04677 03A

EAGLESON, PETER S.
POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

EBERHARDT, ANDREW
JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

ECKENFELDER, W. WESLEY
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

ECKENFELDER, W. W.
NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

ECKERT, E. R. G.
HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

EDE, A. J.
ADVANCES IN FREE CONVECTION,
W70-05038 08B

EISENBERT, D. M.
CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

ELLISON, R. L.
SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

EMELINA, E. P.
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

EMERY, K. O.
ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
W70-05016 02L

ENGLEBRECHT, R. S.
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

ENNIS, C. E.
DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
W70-04670 08C

ERICKSON, L. E.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

ESPEY, WILLIAM H., JR.
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

EVANS, DAVID M.
UNDER THE RUG,
W70-04589 05G

EVANS, D. J.
ANALYSIS OF WAVE FORCE DATA,
W70-04700 08B

EVANS, R. B.
THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

EVERS, D.
TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

FACAOARU, I.
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

FALK, LAURENCE H.
ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
W70-04650 04B

FAN, L. T.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

FARNHAM, C. W.
EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

FAZOLD, A.
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

FEIGE, M. G.
CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,
W70-04667 08G

FEINER, M.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

FELSTEAD, J. E.
BIOLOGICAL TREATMENT SOLVES DYEWORKS EFFLUENT PROBLEMS,
W70-04961 05D

FERGUSON, WILLIAM S.
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

FERRELL, W. K.
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

FINK, F. W.
ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
W70-04929 08G

FISCHBACH, P.
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

FISHER, CHARLES P.
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

FISHER, R.
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

FITZPATRICK, E. A.
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

FLAXMAN, ELLIOTT M.
SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

FOGEL, MARTIN M.
EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

FONG, W.
TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
W70-04967 05D

FORD, DAVIS L.
NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

FOSTER-PEGG, R. W.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

FRANCE, W. D., JR.
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

FRANCISCO, DON
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

FRANCIS, J. R. D.
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

FRANKEL, RICHARD J.
ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

FRANK, RICHARD
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

FRASER, J. H.
VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

FREYDL, R. B.
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

FRITSCHEN, LEO J.
NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

FROST, JUSTIN
EARTH, AIR, WATER,
W70-04585 05B

FRUH, E. GUS
URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

FUJIKAWA, CLIFF Y.
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

FUKUO, YOSHIAKI
VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

GABLINGER, MOSHE
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

GARFIELD, DONALD E.
CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

GAUNT, R. E.
OPERATING EXPERIENCE AT THE MULTI-STAGE FLASH DEMONSTRATION PLANT, POINT LOMA, CALIFORNIA,
W70-04679 03A

GELLMAN, ISAIAH
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

GIOLIOSA, THOMAS E.
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

GIRD, S.
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

GLAZUNOV, I. S.
ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
W70-04608 04B

GLOYNA, EARNEST F.
ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

GLYMPH, L. M.
LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

GOLDBERG, EDWARD D.
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

GOLDBERG, MARVIN C.
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

GOLDSTEIN, R. J.
FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
W70-05042 08B

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

GOLDSTONE, S. E.
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

GOLTERMAN, H. L.
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

GOLUB, S. I.
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

GOLZE, A. R.
RELATIONSHIP BETWEEN STORAGE CAPACITY AND LOAD FACTOR OF A DESALINATION PLANT,
W70-04905 03A

GORSLINE, D. S.
CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

GOULDER, R.
INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
W70-04818 02H

GOWEN, R. A.
TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
W70-05041 08B

GRAHAM, J. R.
CONCRETE PERFORMANCE IN YELLOWTAIL DAM, MONTANT--5-YEAR CORE REPORT,
W70-04628 08F

GRANT, O. L.
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

GREB, B. W.
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

GREENE, M. D.
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

GREENWAY, A. ROGER
FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

GREEN, J. R.
A GENERALIZED PROBABILITY MODEL FOR SEQUENCES OF WET AND DRY DAYS,
W70-04695 02B

GREESON, PHILLIP E.
LAKE EUTROPHICATION -- A NATURAL PROCESS,
W70-04721 05C

GREGORY, W. S.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

GRIFFIN, JOHN J.
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

GRODZENSKY, V. D.
FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

GROSSMAN, E., III
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

GROSS, J. E.
EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

GROSS, M. GRANT
CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

GUILBE, AUSBERTO
QUANTITATIVE ANALYSIS OF RESIDENTIAL WATER-USE PATTERNS IN MAYAGUEZ, PUERTO RICO,
W70-04830 06D

GUILCHER, ANDRE
ORIGIN OF SEDIMENTS IN ESTUARIES,
W70-05013 02L

GUNAJI, N. N.
DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

GUNDERLOY, FRANK C., JR.
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

HAHN, W. J.
OPERATING EXPERIENCES AT THE OSW COAST TEST FACILITY, WRIGHTSVILLE BEACH, NORTH CAROLINA,
W70-04942 03A

HAISE, HOWARD R.
AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
W70-04639 03F

HAMILTON, H. R.
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

HANDA, B. K.
CHEMISTRY OF MANGANESE IN NATURAL WATERS,
W70-04558 02K

HANDY, A. H.
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

HANSEN, DONALD V.
SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

HANSEN, EDWARD A.
RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
W70-04717 02C

HANSEN, R. L.
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

HANSEN, WILLIAM W.
BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXYGEN MODEL,
W70-04771 05D

HARDISON, CLAYTON H.
ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

HARRIS, D. L.
STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

HARRIS, F. L.
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

HARTMAN, MONROE A.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

HART, SAMUEL A.
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

HARWOOD, J. H.
PROBLEMS OF EFFLUENT DISPOSAL,
W70-04963 05D

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
W70-04976 05D

HASSELT, J. W. VAN
EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

HAUSER, V. L.
CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

HAVENS, RICHARD
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

HAWES, R. I.
A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

HAYS, JAMES R.
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

HEATH, MARLA M.
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

HEINEMANN, H. G.
EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

HELLEY, E. J.
FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
W70-04599 02J

HENDRICKS, ALBERT
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

HENLEY, DON
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

HERRIOTT, R. M.
STATEMENT OF CONCERN,
W70-04584 05B

HERSHFIELD, DAVID M.
A NOTE ON AREAL RAINFALL DEFINITION,
W70-04719 02B

HIGGINS, C. H.
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

HILGEMAN, R. H.
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

HISE, E. C.
CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

HOARE, J. L.
NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

HOLCOMBE, H. W.
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

HOLLINGSHAD, W. R.
CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

HOLLINGS, G. I.
CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
W70-04960 05D

HOLMES, J. T.
STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

HOLTAN, H. N.
LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

HOOVER, C. A.
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

HORI, DANIEL H.
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

HOWARD, C. P.
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

HUFSCHMIDT, MAYNARD M.
ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

HUMPHERYS, ALAN S.
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

HUMPHREYS, G. B.
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

HUTCHINSON, D. E.
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

HVEDING, VIDKUNN
DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

HWANG, C. L.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

IBELE, W. E.
HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

INGOLS, ROBERT S.
I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

INGOLS, R. S.
ANAEROBIC DIGESTION TREATS COTTON MILL DE-SIZE WASTES,
W70-04807 05D

ISAKARI, H.
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

ITAHARA, S.
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

IVANUSKI, VICTOR R.
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

IZZARD, CARL F.
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

JACCARINO, E. P.
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

JACKSON, B. N.
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

JACKSON, EUGENE D., III.
A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

JACOBY, HENRY D.
INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

JAUREGUI, L. U.
SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
W70-04637 05D

JENNINGS, J. N.
REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
W70-05001 02L

JHAWAR, M. S.
VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

JOHNSON, ERNEST H.
LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

JOHNSON, HOWARD P.
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

JOHNSON, M. G.
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

JOHNSON, THELMA A.
REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

JOHNSON, WALTER K.
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

JONES, JENNIFER
GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

JONES, L. L., JR.
TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

JONES, R.
RECOMMENDATIONS FOR TESTING CONCRETE BY THE ULTRASONIC PULSE METHOD,
W70-04620 08F

JORGENSEN, ERIK G.
THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
W70-04809 02H

KALOUSEK, G. L.
ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

KARTOVSKI, V. V.
TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

KAZMANN, RAPHAEL G.
THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

KAZMANN, RAPHAEL G.
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

KEECH, C. F.
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

KEELER, CHARLES M.
SOME PHYSICAL PROPERTIES OF ALPINE SNOW,
W70-04739 02C

KEHREN, M.
THE TREATMENT OF STRONG INDUSTRIAL WASTES ON THE CONTINENT,
W70-04965 05D

FLOCCULATION OF TRADE WASTES WITH IRON COMPOUNDS,
W70-04966 05D

DISPOSAL AND CLARIFICATION OF LIQUID WASTES,
W70-04968 05D

CHEMICAL NATURE OF EFFLUENTS FROM THE TEXTILE, LEATHER, AND PAPER INDUSTRIES,
W70-04969 05A

THE PROBLEM OF WASTE WATER TREATMENT,
W70-04970 05D

KENDALL, ROBERT L.
AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
W70-04597 02H

KENNEDY, J. G.
DEVELOPMENTS AND EQUIPMENT IN EFFLUENT TREATMENT,
W70-04977 05D

KERLIN, T. W.
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

KERRI, KENNETH D.
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

KESTIN, J.
THE EFFECT OF FREE STREAM TURBULENCE ON HEAT TRANSFER RATES,
W70-05036 08B

KETCHUM, BOSTWICK H.
PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
W70-04993 02L

KEYES, C. G., JR.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

KIANG, K. D.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

KICKERT, RONALD N.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

KIEFER, RALPH W.
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

KINNEY, LAYTON C.
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

KITANO, KIYOMITSU
A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

KLAUSNER, ROBERT F.
THE EVALUATION OF RISK IN MARINE CAPITAL INVESTMENTS,
W70-04990 06B

KLEIN, GEORGE DE VRIES
COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
W70-05010 02J

KLEIN, G.
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

KLEIN, HOWARD
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

KLEIN, L.
RIVER POLLUTION IN INDUSTRIAL AREAS AN INSOLUABLE PROBLEM,
W70-04587 05D

SOME DIFFERENCES BETWEEN BRITISH, AMERICAN, AND CONTINENTAL PRACTICE,
W70-04971 05D

KLEMES, VIT
CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

KLEMMER, HOWARD W.
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

KNEESE, ALLEN V.
WATER RESOURCES VALUES,
W70-04762 05D

KNUDSEN, D.
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

KOBURGER, CHARLES W., JR.
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

KOCHENOV, A. V.
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

KOCHEVAR, RONALD J.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

KOHLER, MAX
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

KOHOUT, F. A.
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

KOLB, CHARLES R.
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

KONDRATJEV, N. E.
BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
W70-05022 04A

KOPPEL, L. B.
STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

KOPP, JOHN F.
TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

KOS, ZDENEK
DETERMINATION OF THE REQUIRED RESERVOIR STORAGE FOR IRRIGATION UNDER THE CONDITIONS OF COMPENSATION DRAFT,
W70-04745 04A

KOTHANDARAMAN, VEERASAMY
PROBABILISTIC VARIATIONS IN ULTIMATE FIRST STAGE BOD,
W70-04711 05D

KOVALENKO, V. F.
THERMAL DISTILLATION OF SEA WATER - FUNDAMENTALS OF THE THEORY OF MARINE EVAPORATORS,
W70-04676 03A

KRENKEL, PETER A.
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

KRINITZSKY, E. L.
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

KRONER, ROBERT C.
TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

KRUSE, C. W.
STATEMENT OF CONCERN,
W70-04584 05B

KRUSE, E. GORDON
AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
W70-04639 03F

KULM, L. D.
SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

KUMAR, SURENDERA
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

LACHENBRUCH, ARTHUR H.
SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

LAKE, R. A.
SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

LANGBEIN, WALTER B.
RECOMMENDATIONS FOR WATERSHED RESEARCH PROGRAMS,
W70-04760 06B

LANGE, R. T.
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

LATHBURY, ALISON
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

LAURIA, D. T.
TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

LAUTZENHEISER, R. E.
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

LAU, L. STEPHEN
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

LAWRY, T. F.
PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

LEE, G. FRED
AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

LEMON, CHARLES F.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04825 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

LEONTER, A. I.
HEAT AND MASS TRANSFER IN TURBULENT BOUNDARY LAYERS,
W70-05037 08B

LESLIE, D. C.
A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

LETTAU, BERNHARD
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

LEVA, M.
FLOW THROUGH IRRIGATED DUMPED PACKINGS--PRESSURE DROP, LOADING, FLOODING,
W70-04678 03A

LEVITE, G.
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

LEVI, M.
FOG IN ISRAEL,
W70-04915 03B

LEWIS, E. L.
SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

LEWIS, RONALD F.
CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

LEWIS, R. F.
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

LIEBMAN, JON C.
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

LIGHTFOOT, E. N.
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

LIMERINOS, J. T.
RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
W70-04565 02E

LING, JOSEPH T.
PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

LINSLEY, RAY K.
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04544 06A

LITTLEFIELD, C. C.
CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

LITTLE, A. H.
TEXTILE WORKS EFFLUENT TREATMENT,
W70-04831 05D

LI, YUAN-HUI
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

LLOYD, E. H.
PROBABILISTIC RESERVOIR DESIGN,
W70-05031 04A

LONGHURST, ALAN R.
VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXYGEN MINIMUM,
W70-04815 05C

LONGINELLI, A.
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

LONG, F. L.
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

LOTT, PETER F.
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

LOUCKS, DANIEL P.
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

LOVE, R. MERTON
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

LUGIEZ, M. M.
DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

LUNDGREN, H. P.
TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
W70-04967 05D

LUMSFORD, J. V.
DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

LYMAN, J. P.
A NEW RIVAL FOR FLASH DISTILLATION,
W70-04932 03A

MAASLAND, D. E. L.
DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

MACHTA, L.
STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

MADDOCK, THOMAS, JR.
BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
W70-05023 02E

MAIER, G.
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

MAKAR, K. M.
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

MALINA, JOSEPH F., JR.
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

MANCINI, JOHN L.
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

MANCY, K. H.
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

MANGELSDORF, PAUL C., JR.
SALINITY MEASUREMENTS IN ESTUARIES,
W70-04999 02L

MANHEIM, FRANK T.
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

MANKE, PHILLIP G.
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

MARCHER, MELVIN V.
RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

MARKS, DAVID H.
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

MARSDEN, SULLIVAN S., JR.
GEOLOGICAL SUBSIDENCE,
W70-04908 02F

MASCH, FRANK D.
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

MASSELI, J. W.
POLLUTION REDUCTION IN COTTON FINISHING WASTES THROUGH PROCESS CHEMICAL CHANGES,
W70-04972 05D

MATHIEU, GUY
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

MAY, GEORGE D.
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

MCCANN, JAMES A.
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

MCCARTHY, J. A.
CHARACTERISTICS OF WOOL DYEING WASTES AND EXPERIMENTAL TREATMENT,
W70-04586 05D

A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

MCCARTY, PERRY L.
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

MCCLURE, COLE R.
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

MCGUIRE, C. B.
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

MCKINNEY, F. E.
MEASURING MOISTURE WITH GAMMA RADIATION,
W70-04641 08G

MEADE, ROBERT H.
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

MELENTIJEVICH, MIRKO
STORAGE REQUIRED FOR DIFFERENT TYPES OF STREAM FLOW REGULATION,
W70-04744 04A

MELLOR, MALCOLM
UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

MERCER, B. W.
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

MEREDITH, DALE D.
WATER SYSTEMS MODELING,
W70-04901 06A

MERZ, I.
STATEMENT OF CONCERN,
W70-04584 05B

MESSING, T.
COMBINED RECOVERY OF POTABLE WATER AND SEA SALT BY EVAPORATION AN ECONOMIC SOLUTION,
W70-04935 03A

METCALF, T. G.
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

METSON, P.
A ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM BY ELECTROLYTIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING,
W70-04735 02K

MEYER, WLODZIMIERZ
EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

MICKELSON, ROME H.
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

MIHOLITS, EARNEST H.
NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

MILLER, B. D.
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

MILLER, E. H.
FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
W70-04602 02E

MILLIMAN, J. W.
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,

W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII - IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

MINUHIN, L. A.
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

MIXON, F. O.
ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

MODET, J. A.
PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

MOHUNDRO, E. L.
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

MONADJEMI, PARVIZ
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

MOORE, CHARLIE M.
EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
W70-04571 04A

MOORE, ROBERT E.
MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

MOORE, WALTER L.
EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

MORALES, C.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

MORGAN, CARL W.
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

MORGAN, JAMES P.
EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
W70-05000 02L

MOWER, R. W.
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

MROWKA, JACK P.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

MUELLER, H. F.
TREATMENT OF WOOL WASTES,
W70-04626 05D

MULBARGER, M. C.
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

MUNRO, A. L. S.
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

MURPHY, R. SAGE
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

NARAYANA, V. V. DHRUVA
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

NEIL, J. H.
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

NELSON, K. W.
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

NEWMAN, J. E.
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

NEWTON, E. H.
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

NICHOLS, M. M.
SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

NICKS, ARLIN D.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

NIELSEN, E. STEEMANN
THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
W70-04809 02H

NIX, H. A.
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

NORTHROP, VERNON D.
THE DELAWARE RIVER BASIN COMMISSION, A PROTOTYPE IN RIVER BASIN DEVELOPMENT,
W70-04824 06B

NOSHKIN, V. E.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

NOVIKOV, E. P.
TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

OJO, SIMON O.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

OKUBO, AKIRA
OCEANIC MIXING,
W70-04697 02L

OKUN, DANIEL A.
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

OLEVSON, K. L. E.
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

ORCUTT, J. C.
ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

ORR, JAMES R.
EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
W70-04810 02H

OSWALD, W. J.
ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

OWEN, G. E.
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

O'CONNOR, DONALD J.
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

PAK, HASONG
AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

PALMER, J. H.
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

PARCHER, JAMES V.
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

PARSONS, WILLIAM M.
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

PATEL, K.

MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

PATEL, R. D.
STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

PEARSON, ERMAN A.
KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

PECHENICK, W.
DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
W70-04670 08C

PERRI, J. G.
ENGINEERING ASPECTS OF A NUCLEAR DESALTING PLANT,
W70-04925 03A

PETERKA, J. J.
PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
W70-04855 02H

PETERS, HELEN J.
REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

PHILPOT, JOHN W.
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

PIERONI, L. J.
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

POSTMA, H.
SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

PRADOS, J. W.
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

PRITCHARD, DONALD W.
WHAT IS AN ESTUARY PHYSICAL VIEW POINT,
W70-05014 02L

PRITCHETT, H. R.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

PUGH, A. L., III
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

QASIM, SYED R.
LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

RADFORD, E. P.
STATEMENT OF CONCERN,
W70-04584 05B

RANTZ, S. E.
URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

RATTRAY, MAURICE, JR.
SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

RAUSCH, D. L.
SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

RAY, C.
STATEMENT OF CONCERN,
W70-04584 05B

REBHUN, M.
CLARIFICATION OF TURBID WATER WITH POLYELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

REDFIELD, ALFRED C.
THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

REED, SHERWOOD C.
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

REED, S. A.
CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

REINECK, H. E.
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

REYNOLDS, G.
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

RHOADES, EDD D.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

RICHARDSON, CLARENCE W.
EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

RICHARD, O. D.
DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

RIGGS, H. C.
TRANSFERRING STREAMFLOW CHARACTERISTICS,
W70-04554 02E

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

RILEY, J. PAUL
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

ROBERTS, E. B.
CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

ROBERTS, E. G.
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

ROBERTS, P. W.
SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

ROCHLICH, G. A.
FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

ROEHL, JOHN W.
SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,

W70-05025 02J

ROGERS, A. N.
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

ROMANOVA, Z. M.
INVESTIGATION OF WATER STEAM DROP CONDENSATION CONDITIONS,
W70-04927 03A

ROMM, JEFF
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

RORSTROM, E. G.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

ROSTRON, JOSEPH P.
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

ROTHOVIUS, A. E.
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

RUDDY, J.
CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
W70-04960 05D

RUHE, R. V.
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

RUSNAK, GENE A.
RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
W70-05012 02L

SADAMOTO, K.
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

SAELEN, ODD H.
SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
W70-05003 02L

SANDBERG, G. W.
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

SANGAL, SURESH
EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

SAWYER, CLAIR N.
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,
W70-04782 05D

SCHIEFNER, K.
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

SCHLEIF, F. R.
EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
W70-04623 08C

SCHMORAK, S.
SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
W70-04613 02L

SCHNEIDER, WILLIAM J.
THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

SCHOOF, RUSSELL R.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

SCHOW, AXEL
ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

SCHRAMM, M.
QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

SCHROER, FRED W.
A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
W70-04985 03C

SCHUBEL, J. R.
TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

SCHWARTZ, ARNOLD E.
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

SCOTT, RONALD F.
THE PHYSICS AND MECHANICS OF SOIL,
W70-04631 08D

SECKLER, J. G.
DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

SEEVERS, WILLIAM J.
GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

SEGINER, IDO
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

SEIDEN, L.
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

SENATORE, S. J.
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

CONCEPTUAL DESIGN STUDY OF A 1-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW,
W70-04939 03A

STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART I, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

SEPHTON, H. H.
AN INVESTIGATION ON THE DISTILLATION OF BRINE BY VERTICAL TUBE EVAPORATION UTILIZING THE SEPHTON FLASH TUBE (VORTEX TUBE) PROCESS,
W70-04665 03A

SERGEENKO, I. L.
COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

SERGEYENKO, I. L.
ANALYSIS OF THE ECONOMICS OF LARGE CAPACITY THERMAL DESALINATION PLANTS,
W70-04672 03A

SEROVA, V. V.
THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

SEWARD, LEWIS B.
INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

SHATSILLO, V. G.
TEST OF THE PILOT DESALTING PLANT WITH RECIRCULATING SEED,
W70-04928 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

SHEA, E. P.
CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

SHERWANI, JABBAR K.
OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

SHULMAN, MARK D.
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

SHUSTER, J. C.
DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

SHUYSKIY, YU. D.
THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
W70-04566 02L

SIEDER, E. N.
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

SILBERNAGEL, S. B.
DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

SIMPSON, H. J.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

SIMS, J. R.
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

SIMS, H. H.
TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

SLANETZ, L. W.
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

SMIRNOV, S. I.
FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
W70-04570 02K

SMITH, ALVIN L., JR.
AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

SMITH, FRANK A.
AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

SMITH, JAMES H.
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

SMITH, J. A.
CONCEPTUAL DESIGN STUDY OF A 1-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW,
W70-04939 03A

STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART 1, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

SMITH, J. W.
TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
W70-05041 08B

SMITH, NORMAN A. F.
. . . THE ROMAN DAMS OF SUBIACO,
W70-04980 08A

SMITH, ROBERT L.
AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

SMITH, W.
FLASH DESALINATION PLANT - THE RESULTS OF THE FIRST TEN YEARS OF DEVELOPMENT AND FIELD PROVING,
W70-04926 03A

SOBOLEV, E. A.
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

COMPARISON OF ECONOMIC DATA OF THE MAIN TYPES OF THE DESALTING DISTILLATION PLANTS,
W70-04947 03A

SOUCEK, VLADMIR
DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

SOUTHER, R. HOBART
IV. WASTE WATER CONTROL AND WATER CONSERVATION,
W70-04853 05D

SOUTHER, R. H.
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

SPARROW, E. M.
FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
W70-05042 08B

SPIEWAK, I.
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

SPINKS, RALEIGH
BACKGROUND MATERIAL COVERING THE FEASIBILITY OF CREATING ISLANDS IN LAKE MICHIGAN NEAR CHICAGO,
W70-04899 06B

SQUIRES, B.
DYNAMICS EXPERIMENTS ON THE AMF HILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

STANDIFOR, F. C.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

STARLING, CHARLES
III. PROBLEMS OF TEXTILE CHEMICAL WASTES,
W70-04852 05D

STARNER, R.
PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

STASIAK, JADWIGA
HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

STEAD, FRANK M.
DESALTING CALIFORNIA,
W70-04583 05G

STEELE, HARRY A.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04826 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

STEFFEN, A. J.
WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

STEINBRUCHEL, A. B.
CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
W70-04660 03A

STEINER, WESLEY E.
THE WATER SITUATION,
W70-04914 03B

STEWART, J. M.
SOME PRACTICAL ASPECTS OF DESALINATION BY EVAPORATION,
W70-04657 03A

STEWART, N. G.
NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

STIEL, L. I.
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

STOERMER, EUGENE F.
PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
W70-04902 05C

STOESZ, A. D.
RESOURCE CONSERVATION GLOSSARY,
W70-04559 10

STUMP, VERNON L.
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

SUTCLIFFE, HARRY
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

SVORE, JEROME H.
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

SWEETMAN, B. J.
NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

SWEET, D. C.
A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

SZESZTAY, K.
SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
W70-04757 02H

TAKACS, S.
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

TALLING, J. F.
PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

TELEGADAS, K.
STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

TERASE, H.
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

TERJUNG, WERNER H.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,

W70-04734 02B

THOMPSON, J. R.
SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
W70-04557 02J

THOMPSON, S. A.
CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

THORNLEY, F. C.
PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

THRASHER, L. W.
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

TIDBALL, R. A.
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

TLEIMAT, B. W.
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

TOFANI, R. J.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION-VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04827 06B

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

TORREN, J. H. VAN DER
EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

TOUHILL, C. J.
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

TOWNSEND, FRANK C.
EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

TOWNSEND, MAHLON L.
WATER RIGHTS IN TENNESSEE,
W70-04874 06E

WATER RIGHTS IN TENNESSEE (FLOWING STREAMS),
W70-04875 06E

WATER RIGHTS IN TENNESSEE (DIFFUSED SURFACE WATERS AND UNDERGROUND WATERS),
W70-04876 06E

TRAINER, FRANK W.
PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
W70-04581 02A

TRIBUS, M.
THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

TRIMONIS, YE. S.
COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

TROCK, WARREN L.
EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
W70-04983 06B

TRUESDALE, F. M.
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

TSOU, P. K.
FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
W70-05042 08B

TSUCHIYA, YOSHITO
MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

TURNER, MARVIN E.
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

UEDA, HERBERT T.
CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

VAN BAVEL, C. H. M.
CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

VAN CLEVE, PAUL W.
ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

VAN DER MADE, J. W.
FLOOD PREVENTION BY ENLARGEMENT OF FLOOD WAVE SUBSIDENCE,
W70-04750 04A

VAN DUUREN, FRANCOIS A.
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

VAN FLEET, G. L.
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

VAN SLYKE, W. J.
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

VAN WINKLE, R.
DYNAMICS EXPERIMENTS ON THE AMF MILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

VANDERTULIP, JOHN J.
INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

VANSICKLE, DONALD
EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

VERMEULEN, T.
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

VISKANTA, R.
RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
W70-05035 08B

VOLCHOK, H. L.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

VON CONNER, J.
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

VON DER EMDE, WILHELM
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

VORWERK, H. J.
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

VREEKEN, W. J.
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

WAANANEN, ARVI O.
URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

WACHS, ALBERTO M.
EXTRA-DEEP PONDS,
W70-04790 05D

WAITE, G. GRAHAM
INDIANA WATER LAW AND SUGGESTIONS FOR ACTION,
W70-04857 06E

W70-04858 06E

W70-04859 06E

W70-04860 06E

W70-04861 06E

W70-04862 06E

W70-04863 06E

W70-04864 06E

W70-04865 06E

W70-04866 06E

W70-04867 06E

W70-04868 06E

W70-04869 06E

WALSH, H. R. J.
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,

W70-04635 08D

WARNER, D. L.
CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
W70-04615 02K

WARSKOW, WILLIAM L.
MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

WAUGH, WILLIAM R.
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

WEIDENKOPF, STANLEY J.
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

WEISBLATT, M. B.
ANALYSIS OF DIFFERENT DESIGNS OF DISTILLATION DESALINATION,
W70-04658 03A

WEISMANTEL, G. E.
RECYCLE BOOSTS DESALTING EFFICIENCY,
W70-04938 03A

WELLS, DAN M.
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

WENDT, CHARLES W.
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

WERSHAW, ROBERT L.
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

WESTMAN, J. R.
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

WEYDERT, PIERRE
A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

WHEELER, J. D.
METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

WHITAKER, D. R.
ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

WHITFORD, PETER W.
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04544 06A

WIERSMA, JAMES H.
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

WIGHTMAN, H.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

WILLIAMSON, T. G.
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

WILLIAMS, B. P. J.
THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

WILLIS, C. A.
TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

WILROY, ROBERT D.
II. THE FEASIBILITY OF TREATING TEXTILE WASTES IN CONNECTION WITH DOMESTIC SEWAGE,
W70-04851 05D

WILSON, DAVID S., JR.
MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

WILSON, JOE B.
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

WILSON, JOHN E.
SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

WINANS, D. C.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

WINSLOW, DAVID E.
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

WOHLSCHLAG, DONALD E.
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

WOLPE, CHARLES G.
SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

WONG, CHUNG-MING
FRESH WATER SUPPLIES THROUGH DESALINATION,
W70-04647 03A

WOODBURY, R. E.
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

WOOD, C. D.
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

WOOLDRIDGE, DAVID D.
EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

WRIGHT, W. C.
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

WUHRMANN, KARL
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND DARE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

YANG, J. J.
PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
W70-04902 05C

YOUNG, REGINALD H. F.
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

ZABIROV, R. D.
HISTORY OF THE DEVELOPMENT OF LAKE ISSIK-KUL. (IN FRENCH),
W70-05021 02H

ZAVITKOVSKI, J.
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

ZMIEVA, E. S.
METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
W70-05019 04A

ZUCKERMAN, M.
THE EILAT 1,000,000 GPD, MSF, DISTILLATION PLANT OPERATING EXPERIENCE,
W70-04948 03A

ZWACK, PETER P.
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

ORGANIZATIONAL INDEX

ADELAIDE UNIV. (AUSTRALIA). DEPT. OF BOTANY.
EFFECTS OF MODERATE SHEEP STOCKING ON PLANT POPULATIONS OF A BLACK OAK-BLUEBUSH ASSOCIATION,
W70-04911 03F

AGRICULTURAL RESEARCH SERVICE, AKRON, COLO. CENTRAL GREAT PLAINS FIELD STATION.
LAGOON LEVELING TO PERMIT ANNUAL CROPPING IN SEMIARID AREAS,
W70-04555 04A

AGRICULTURAL RESEARCH SERVICE, ALBANY, CALIF. WESTERN UTILIZATION RESEARCH AND DEVELOPMENT DIV.
TREATMENT OF WOOL SCOURING WASTES WITH COLLOIDAL BENTONITE,
W70-04967 05D

AGRICULTURAL RESEARCH SERVICE, ATHENS, GA. SOIL AND WATER CONSERVATION RESEARCH DIV. AND GEORGIA AGRICULTURAL EXPERIMENT STATION, ATHENS.
IRRIGATING VEGETABLES WITH BRACKISH WATER,
W70-04906 03C

AGRICULTURAL RESEARCH SERVICE, BELTSVILLE, MD. HYDROGRAPH LAB.
A NOTE ON AREAL RAINFALL DEFINITION,
W70-04719 02B

AGRICULTURAL RESEARCH SERVICE, BELTSVILLE, MD. SOIL AND WATER CONSERVATION RESEARCH DIV.
LAND TREATMENT IN AGRICULTURAL WATERSHED HYDROLOGY RESEARCH,
W70-04725 04D

AGRICULTURAL RESEARCH SERVICE, CHICKASHA, OKLA. SOUTHERN PLAINS BRANCH.
FIELD EXPERIMENT ON WASHITA RIVER,
W70-04572 04D

AGRICULTURAL RESEARCH SERVICE, COLUMBIA, MO. SOIL AND WATER CONSERVATION DIV., AND MISSOURI UNIV., COLUMBIA. DEPT. OF ZOOLOGY.
SEDIMENTATION IN A SMALL CHANNEL-TYPE RESERVOIR,
W70-04753 02J

AGRICULTURAL RESEARCH SERVICE, FORT COLLINS, COLO.
AUTOMATION OF SURFACE IRRIGATION SYSTEMS,
W70-04639 03F

AGRICULTURAL RESEARCH SERVICE, KIMBERLY, IDAHO. SNAKE RIVER CONSERVATION RESEARCH CENTER.
MECHANICAL STRUCTURES FOR FARM IRRIGATION,
W70-04638 03F

AGRICULTURAL RESEARCH SERVICE, PHOENIX, ARIZ. WATER CONSERVATION LAB.
FIELD MEASUREMENT OF SATURATED HYDRAULIC CONDUCTIVITY IN INITIALLY UNSATURATED SOIL,
W70-04607 02G

GROUNDWATER RECHARGE DESIGN FOR RENOVATING WASTE WATER,
W70-04712 05D

AGRICULTURAL RESEARCH SERVICE, PHOENIX, ARIZ. WATER CONSERVATION LAB. AND ARMY ELECTRONICS COMMAND, FORT HUACHUCA, ARIZ. ATMOSPHERIC SCIENCES LAB.
CHANGES IN CANOPY RESISTANCE TO WATER LOSS FROM ALFALFA INDUCED BY SOIL WATER DEPLETION,
W70-04921 02D

AGRICULTURAL RESEARCH SERVICE, PHOENIX, ARIZ. WATER CONSERVATION LAB.
NET AND SOLAR RADIATION RELATIONS OVER IRRIGATED FIELD CROPS,
W70-04922 02D

AGRICULTURAL RESEARCH SERVICE, RIESEL, TEXAS. SOUTHERN PLAINS BRANCH AND TEXAS AGRICULTURAL EXPERIMENT STATION, RIESEL.
EFFECTS OF CONSERVATION TREATMENTS ON WATER YIELD,
W70-04730 03F

AKADEMIYA NAUK SSSR, NOVOSIBIRSK.
HEAT AND MASS TRANSFER IN TURBULENT BOUNDARY LAYERS,
W70-05037 08B

AKADEMIYA NAUK SSSR. INSTITUT OKEANOLOGII.
THE EFFECT OF STRONG STORMS ON SAND BEACHES OF THE BALTIC EASTERN SHORE,
W70-04566 02L

THE MINERALOGICAL COMPOSITION OF SUSPENDED MATTER IN THE INDIAN OCEAN,
W70-04568 02L

COMPOSITION AND ORIGIN OF IRON-ORE SEDIMENTS AND HOT BRINES IN THE RED SEA,
W70-04569 02K

ALASKA UNIV., COLLEGE.
LOW TEMPERATURE ACTIVATED SLUDGE SETTLING,
W70-04800 05D

ALBERTA UNIV., EDMONTON AND GEORGIA INST. OF TECH., ATLANTA. SCHOOL OF CIVIL ENGINEERING.
A FRESH-WATER CANAL AS A BARRIER TO SALT-WATER INTRUSION,
W70-04610 04B

ALL-UNION SCIENTIFIC RESEARCH INST. OF HYDROGEOLOGY AND ENGINEERING GEOLOGY, MOSCOW (USSR).
FORMATION OF BRINES IN BOTTOM DEPRESSIONS OF THE RED SEA,
W70-04570 02K

ARTIFICIAL FORMATION OF FRESH GROUNDWATER LENSES BY MEANS OF WELLS,
W70-04608 04B

FORMATION OF FRESH GROUNDWATER LENSES AS A RESULT OF PERCOLATION FROM CANALS AND PITS,
W70-04611 04B

AMERICAN CONCRETE INST., DETROIT, MICH.
PRECAST CONCRETE UNITS USED AS FORMS FOR CAST-IN-PLACE CONCRETE,
W70-04629 08F

AMERICAN SOCIETY OF CIVIL ENGINEERS. WASHINGTON, D.C. NATIONAL CAPITOL SECTION.
NATIONAL POLICY PROBLEMS IN WATER RESOURCES.
W70-04978 06B

APPLIED RESEARCH AND ENGINEERING LTD., DURHAM (ENGLAND) AND INTERNATIONAL COMBUSTION EXPORT LTD., LONDON (ENGLAND).
PROBLEMS LIKELY TO BE ENCOUNTERED IN THE DESIGN OF LARGE FLASH DISTILLATION PLANT,
W70-04959 03A

APPLIED RESEARCH AND ENGINEERING LTD., DURHAM (ENGLAND).
COST OF WATER FROM A SINGLE-PURPOSE MULTISTAGE FLASH PLANT WITH VAPOUR RECOMPRESSION.
W70-04675 03A

AQUA-CHEM, INC., MILWAUKEE, WIS.
CURRENT AND PROJECTED TECHNOLOGY OF FLASH TYPE SEA WATER DESALTING PLANTS,
W70-04660 03A

AQUA-CHEM, INC., WAUKESHA, WIS.
RESEARCH AND DEVELOPMENT ON THE HORIZONTAL SPRAY FILM EVAPORATOR.
W70-04671 03A

ARGONNE NATIONAL LAB., ILL.
STATISTICAL MODELS FOR SURFACE RENEWAL IN HEAT AND MASS TRANSFER,
W70-05039 08B

ARIZONA CONSERVATION COUNCIL.
ESTHETIC INTERESTS IN WATER YIELD IMPROVEMENT,
W70-04917 03B

ARIZONA STATE WATER ENGINEER AND ARIZONA INTERSTATE STREAM COMMISSION.
THE WATER SITUATION,
W70-04914 03B

ARIZONA WATER RESOURCES RESEARCH CENTER, TUCSON.
EFFECT OF STORM RAINFALL VARIABILITY ON RUNOFF FROM SMALL SEMIARID WATERSHEDS,
W70-04910 02A

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.
GEOLOGICAL INFLUENCES ON THE STABILITY OF CLAY SHALE SLOPES,
W70-04644 08D

ARMY TERRESTRIAL SCIENCES CENTER, HANOVER, N.H.
IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA,
W70-04736 02K

SOME PHYSICAL PROPERTIES OF ALPINE SNOW,
W70-04739 02C

UTILITIES ON PERMANENT SNOWFIELDS,
W70-04740 03D

CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET,
W70-04741 02C

RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA,
W70-04742 02C

ATOMIC ENERGY ESTABLISHMENT, WINFRITH (ENGLAND).
A STUDY OF THE MECHANISM OF FLASHING FLOW BY EXPERIMENT AND THEORETICAL ANALYSIS,
W70-04956 03A

AUSTRALIAN NATIONAL UNIV. (CANBERRA).
REGIONAL GEOMORPHOLOGICAL CHARACTERISTICS OF SOME AUSTRALIAN ESTUARIES,
W70-05001 02L

BALDWIN-LIMA-HAMILTON CORP., EDDYSTONE, PA.
OPERATION OF THE 16-STAGE HIGH-TEMPERATURE FLASH PILOT PLANT,
W70-04937 03A

BATTELLE MEMORIAL INST., COLUMBUS, OHIO AND WEST VIRGINIA UNIV., MORGANTOWN. DEPT. OF CIVIL ENGINEERING.
LEACHING OF POLLUTANTS FROM REFUSE BEDS,
W70-04714 05A

BATTELLE MEMORIAL INST., COLUMBUS, OHIO INDIANA UNIV., BLOOMINGTON MASSACHUSETTS INST. OF TECH., CAMBRIDGE AND CHICAGO UNIV., ILL.
SYSTEMS SIMULATION FOR REGIONAL ANALYSIS,
W70-04835 06A

CHAPTER I INTRODUCTION AND SUMMARY,
W70-04836 06A

CHAPTER II PERSPECTIVES ON MATHEMATICAL MODELS IN THE SOCIAL SCIENCES,
W70-04837 06A

CHAPTER III REGIONAL ECONOMIC ANALYSIS AND RIVER BASIN PLANNING,
W70-04838 06A

CHAPTER IV CONTEMPORARY REGIONAL PROJECTION MODELS,
W70-04839 06A

CHAPTER V PHILOSOPHY AND METHODOLOGY OF APPROACH,
W70-04840 06A

CHAPTER VI THE REGIONAL SETTING OF THE STUDY,
W70-04841 06A

CHAPTER VII AN OVERVIEW OF THE MODEL,
W70-04842 06A

CHAPTER XI THE WATER SECTOR,
W70-04843 06A

CHAPTER XIII IMPLICATIONS OF THE MODEL-BUILDING EFFORT FOR FUTURE RESEARCH,
W70-04844 06A

APPENDIX A THE MANAGEMENT OF A MULTIDISCIPLINARY RESEARCH PROJECT,
W70-04845 06A

BATTELLE MEMORIAL INST., COLUMBUS, OHIO.
WATER RESOURCES SYSTEMS ANALYSIS--AN OVERVIEW,
W70-04900 06A

ALLOY SELECTION FOR HEAT-EXCHANGER SERVICE IN SEAWATER-CONVERSION PLANTS,
W70-04929 08G

A DYNAMIC MODEL OF THE ECONOMY OF THE SUSQUEHANNA RIVER BASIN,
W70-04992 04A

BATTELLE MEMORIAL INST., RICHLAND, WASH. PACIFIC NORTHWEST LABS.
AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE.
W70-04982 05D

BATTELLE MEMORIAL INST., RICHLAND, WASH. AND FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO.
AMMONIA REMOVAL FROM SECONDARY EFFLUENTS BY SELECTIVE ION EXCHANGE,
W70-04804 05D

BECHTEL CORP., SAN FRANCISCO, CALIF.
LARGE AGGREGATE SHOTCRETE CHALLENGES STEEL RIBS AS A TUNNEL SUPPORT,
W70-04636 08F

OPTIMUM BRINE HEATER OUTLET TEMPERATURE IN SEA WATER CONVERSION EVAPORATORS.
W70-04955 03A

BERGEN UNIV. (NORWAY). INST. OF GEOGRAPHY.
SOME FEATURES OF THE HYDROGRAPHY OF NORWEGIAN FJORDS,
W70-05003 02L

BOEING CO., HUNTSVILLE, ALA. AND VANDERBILT UNIV., NASHVILLE, TENN.
MATHEMATICAL MODELING OF MIXING PHENOMENA IN RIVERS,
W70-04770 05D

BOLTON AND DISTRICT JOINT SEWAGE BOARD.
EFFECTS OF TRADE EFFLUENTS ON ACTIVATED SLUDGE TREATMENT AND OBSERVATIONS UPON RESIDUAL IMPURITIES IN EFFLUENTS,
W70-04588 05D

BROWN UNIV., PROVIDENCE, R. I. DIV. OF ENGINEERING.
THE EFFECT OF FREE STREAM TURBULENCE ON HEAT TRANSFER RATES,
W70-05036 08B

BROWN, BOVERI AND CO. LTD., BADEN (SWITZERLAND).
DIELECTRIC STRENGTH OF OIL-IMPREGNATED INSULATION UNDER HVDC STRESSES,
W70-04640 08C

BUCKLEY AND TAYLOR LTD., OLDHAM (ENGLAND).
FLASH DESALINATION PLANT - THE RESULTS OF THE FIRST TEN YEARS OF DEVELOPMENT AND FIELD PROVING,
W70-04926 03A

BUREAU OF MINES, BARTLESVILLE, OKLA. PETROLEUM RESEARCH CENTER.
GEOCHEMISTRY OF SOME PETROLEUM-ASSOCIATED WATERS FROM LOUISIANA,
W70-04710 02K

BUREAU OF MINES, SALT LAKE CITY, UTAH. SALT LAKE CITY METALLURGY RESEARCH CENTER.
CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZONA,
W70-04888 05G

BUREAU OF RECLAMATION, DENVER, COLO.
EXCITATION CONTROL FOR SYSTEM DAMPING TESTS ON MODEL SYSTEM,
W70-04623 08C

ABNORMAL SET OF PORTLAND CEMENT - CAUSES AND CORRECTIVES,
W70-04627 08F

CONCRETE PERFORMANCE IN YELLOWTAIL DAM, MONTANT--5-YEAR CORE REPORT,
W70-04628 08F

DISCHARGE MEASUREMENTS USING THE RADIOISOTOPE VELOCITY, INTEGRATED SAMPLE, DILUTION, AND TOTAL COUNT METHODS AT FLATIRON POWER AND PUMPING PLANT, COLORADO-BIG THOMPSON PROJECT,
W70-04645 08C

LARGE COMBINED AXIAL- AND MIXED-FLOW PUMP,
W70-04894 08C

BUREAU OF SPORT FISHERIES AND WILDLIFE, AMHERST, MASS.
AN INVENTORY OF THE PONDS, LAKES, AND RESERVOIRS OF MASSACHUSETTS-BARNSTABLE COUNTY,
W70-04651 07C

BURNS AND ROE, INC., NEW YORK.
ENGINEERING ASPECTS OF A NUCLEAR DESALTING PLANT,
W70-04925 03A

CALIFORNIA INST. OF TECH., PASADENA.
THE PHYSICS AND MECHANICS OF SOIL,
W70-04631 08D

CALIFORNIA STATE DEPT. OF PUBLIC HEALTH, SACRAMENTO. ENVIRONMENTAL SANITATION DIV.
DESALTING CALIFORNIA,
W70-04583 05G

CALIFORNIA STATE DEPT. OF WATER RESOURCES, LOS ANGELES.
REGIONAL INTEGRATION OF SURFACE AND GROUNDWATER RESOURCES,
W70-04604 04B

CALIFORNIA UNIV., BERKELEY.
DESIGN AND COST OF ION-EXCHANGE SOFTENING FOR A 50-MGD SEAWATER EVAPORATION PLANT,
W70-04661 03A

AN INVESTIGATION ON THE DISTILLATION OF BRINE BY VERTICAL TUBE EVAPORATION UTILIZING THE SEPHTON FLASH TUBE (VORTEX TUBE) PROCESS,
W70-04665 03A

KINETICS OF BIOLOGICAL TREATMENT,
W70-04785 05D

ADVANCES IN ANAEROBIC POND SYSTEMS DESIGN,
W70-04787 05D

CALIFORNIA UNIV., BERKELEY. CENTER FOR RESEARCH IN MANAGEMENT SCIENCE.
RATIONAL INVESTMENT BEHAVIOR IN THE FACE OF FLOODS,
W70-04689 06F

CALIFORNIA UNIV., DAVIS AND KANSAS STATE UNIV., MANHATTAN.
WASTE STABILIZATION PONDS FOR AGRICULTURAL WASTES,
W70-04791 05D

CALIFORNIA UNIV., DAVIS. DEPT. OF AGRONOMY.
THE RANGELANDS OF THE WESTERN U.S.,
W70-04907 03B

CALIFORNIA UNIV., LOS ANGELES. DEPT. OF GEOGRAPHY.
THE ANNUAL MARCH OF THE TOPOCLIMATIC SPATIAL PATTERNS OF NET RADIATION IN SOUTHERN CALIFORNIA,
W70-04734 02B

CALIFORNIA UNIV., RIVERSIDE AND ARIZONA AGRICULTURAL EXPERIMENT STATION, TUCSON.
CLIMATE AND ESTIMATED WATER USE BY AN ORANGE ORCHARD,
W70-04923 02D

CALIFORNIA UNIV., RIVERSIDE. DEPT. OF ECONOMICS.
THE ECONOMICS OF URBAN SEWAGE DISPOSAL,
W70-04648 05D

CALIFORNIA UNIV., SAN DIEGO, LA JOLLA. INST. OF MARINE RESOURCES.
VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION TO THE EASTERN PACIFIC OXIGEN MINIMUM,
W70-04815 05C

DETERMINATION OF VITAMINS IN SEAWATER,
W70-04823 07B

CAMP, DRESSER, AND MCKEE, BOSTON, MASS.
PILOT-PLANT TREATMENT IN SEWAGE-TEXTILE WASTE MIXTURES,
W70-04975 05D

CANADIAN INDUSTRIES LTD., MONTREAL (QUEBEC).
THE PREVENTION OF WATER POLLUTION WITH SPECIAL REFERENCE TO SOME ASPECTS OF THE TEXTILE INDUSTRY,
W70-04799 05D

CANTON TEXTILES, INC.
TEXTILE WASTE TREATMENT AT CANTON COTTON MILLS,
W70-04964 05D

CARNEGIE-MELLON UNIV., PITTSBURGH, PA. DEPT. OF CIVIL ENGINEERING.
A STOCHASTIC MODEL OF CONVECTIVE DIFFUSION FROM A CONTINUOUS SOURCE,
W70-04563 02A

CARTER (RALPH B.) CO., HACKENSACK, N.J.

WASTE TREATMENT IN THE MEAT PROCESSING INDUSTRY,
W70-04793 05D

CATALYTIC CONSTRUCTION CO., PHILADELPHIA, PA.
DESALINATION PLANTS USING HIGHER STEAM PRESSURES,
W70-04670 08C

CATHOLIC UNIV. OF AMERICA, WASHINGTON, D.C.
EVAPORATIVE FREEZING PROCESS FOR WATER DESALINATION,
W70-04649 03A

CENTRE UNIVERSITAIRE MARSEILLE-LUMINY, MARSEILLE (FRANCE). GEOLOGY LAB.
A NEW METHOD TO DETERMINE THE SPHERICITY OF MOBILE SEDIMENTS,
W70-04731 02J

CHEVRON OIL FIELD RESEARCH CO.
MEASURED WAVE FORCE DATA ON OFFSHORE PLATFORMS,
W70-04699 08B

CHUBU ELECTRIC POWER CO. (JAPAN).
DIELECTRIC STRENGTH RECOVERY CHARACTERISTICS AFTER FAULT ARC EXTINCTION IN 500-KV TRANSMISSION LINES,
W70-04642 08C

CLEMSON UNIV., S.C.
A DROP HAMMER PENETROMETER FOR DETERMINING THE DENSITY OF SOILS AND GRANULAR MATERIALS,
W70-04633 08D

CLUETT, PEABODY CO., INC., NEW YORK.
WASTE TREATMENT STUDIES AT CLUETT, PEABODY AND COMPANY FINISHING PLANT,
W70-04945 05D

COAST GUARD, WASHINGTON, D.C. MARITIME POLLUTION CONTROL BRANCH.
OUR NAVIGABLE WATERS -- POLLUTED AND OTHERWISE,
W70-04887 05G

COLORADO SCHOOL OF MINES, GOLDEN. MINERAL RESOURCES INST.
UNDER THE RUG,
W70-04589 05G

COLORADO UNIV., BOULDER.
EXACT SIMILAR SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS,
W70-05040 08B

COLT INDUSTRIES, INC., BELOIT, WIS.
VACUUM FREEZING VAPOR COMPRESSION PROCESS EVALUATION ON BRACKISH WATER,
W70-04890 03A

COMMITTEE ON APPROPRIATIONS (U.S. SENATE).
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04828 06B

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, GRIFFITH (AUSTRALIA). IRRIGATION RESEARCH LAB.
DIURNAL VARIATION IN LEAF AND BOLL TEMPERATURES OF IRRIGATED COTTON GROWN UNDER TWO SOIL MOISTURE REGIMES IN A SEMI-ARID CLIMATE,
W70-04912 02I

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, CANBERRA (AUSTRALIA). DIV. OF LAND RESEARCH AND REGIONAL SURVEY.
A MODEL FOR SIMULATING SOIL WATER REGIME IN ALTERNATING FALLOW-CROP SYSTEMS,
W70-04920 02D

AN INDEX OF CROP WATER STRESS RELATED TO WHEAT AND GRAIN SORGHUM YIELDS,
W70-04924 02D

COPENHAGEN UNIV. (DENMARK). GEOGRAPHICAL LAB.
ESTUARINE RESEARCH IN THE DANISH MORAINE ARCHIPELAGO,
W70-04995 02L

CORNELL UNIV., ITHACA, N.Y.
DEVELOPMENTS IN BIOLOGICAL FILTRATION,
W70-04776 05D

CORNELL UNIV., ITHACA, N.Y. DEPT. OF AGRICULTURAL ECONOMICS.
THE VALUE OF RESERVOIR RECREATION,
W70-04829 06B

CORNELL UNIV., ITHACA, N.Y. SCHOOL OF CIVIL ENGINEERING.
MARKOV MODELS FOR FLOW REGULATION,
W70-04987 06A

CORNELL UNIV., ITHACA NEW YORK STATE COLL. OF AGRICULTURE, ITHACA. DEPT. OF AGRONOMY.
THE EFFECT OF ALBEDO ON THE EVAPOTRANSPIRATION RATE,
W70-04919 02D

CORPS OF ENGINEERS, BONNEVILLE, OREG.
30 YEARS OF MAINTENANCE EXPERIENCE WITH LARGE KAPLAN TURBINES,
W70-04646 08C

CORPS OF ENGINEERS, HONOLULU, HAWAII.
FLOOD PLAIN INFORMATION, KIHEI, MAUI, HAWAII.
W70-04713 04A

CORPS OF ENGINEERS, ROCK ISLAND, ILL., IOWA UNIV., AMES, AND AGRICULTURAL RESEARCH SERVICE, COLUMBIA, MO.
EVALUATION OF FACTORS AFFECTING RESERVOIR SEDIMENT DEPOSITION,
W70-04752 02J

CORPS OF ENGINEERS, SAVANNAH, GA.
FLOOD PLAIN INFORMATION, HORSE CREEK, AIKEN COUNTY, SOUTH CAROLINA.
W70-04738 04A

DARTMOUTH COLL., HANOVER, N.H.
THERMOECONOMIC DESIGN UNDER CONDITIONS OF VARIABLE PRICE STRUCTURE,
W70-04936 03A

DELAWARE RIVER BASIN COMMISSION, WASHINGTON, D.C.
THE DELAWARE RIVER BASIN COMMISSION, A PROTOTYPE IN RIVER BASIN DEVELOPMENT,
W70-04824 06B

DELAWARE UNIV., NEWARK.
PROBLEMS IN DESIGN AND RESEARCH ON CONDENSERS OF VAPORS AND VAPOR MIXTURES,
W70-04664 03A

DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS (UN).
RELATIONSHIP BETWEEN STORAGE CAPACITY AND LOAD FACTOR OF A DESALINATION PLANT,
W70-04905 03A

DEPARTMENT OF ENERGY, MINES AND RESOURCES, DARTMOUTH (NOVA SCOTIA).
SALT REJECTION BY SEA ICE DURING GROWTH,
W70-04703 02C

DEPARTMENT OF THE INTERIOR, WASHINGTON, D.C.
FRESH WATER SUPPLIES THROUGH DESALINATION,
W70-04647 03A

DETROIT EDISON CO., MICH.
SONIC POLE TESTS PROVE RELIABLE AND INEXPENSIVE,
W70-04622 08C

DUKE UNIV., DURHAM, N. C. DEPT. OF ZOOLOGY.
AN ECOLOGICAL HISTORY OF THE LAKE VICTORIA BASIN,
W70-04597 02H

EIDGENOESSISCHE TECHNISCHE HOCHSCHULE, ZURICH (SWITZERLAND).
OBJECTIVES, TECHNOLOGY, AND RESULTS OF NITROGEN AND PHOSPHORUS REMOVAL PROCESSES,
W70-04764 05D

RESEARCH DEVELOPMENTS IN REGARD TO CONCEPT AND BASE VALUES OF THE ACTIVATED SLUDGE SYSTEM,
W70-04772 05D

ELECTRICITE DE FRANCE, CHATOU. CENTRE DE RECHERCHES ET D'ESSAIS.
ON THE SAFETY GIVEN BY A SEASONAL REGULATION RESERVOIR. (IN FRENCH),
W70-05028 04A

ELECTRICITE DE FRANCE, GRENOBLE. GENERAL TECHNICAL DIV.
DISPOSABLE VOLUMES AND FLOW CONTROL IN HYDROELECTRIC RESERVOIRS. (IN FRENCH),
W70-05030 04A

ENTE NAZIONALE PER L'ENERGIA ELETTRICA, VENICE (ITALY).
APPLICATION OF A METHOD BASED ON THE CALCULUS OF PROBABILITY IN THE ELABORATION OF HYDROLOGIC DATA,
W70-05032 04A

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, BOSTON, MASS.
REMARKABLE POINT RAINFALL AT GREENFIELD, N.H., EVENING OF AUGUST 2, 1966,
W70-04698 02B

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, SILVER SPRING, MD.
STRONTIUM-90 FALLOUT OVER LAKE MICHIGAN,
W70-04705 05B

ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER (AIR FORCE), WASHINGTON, D.C.
AN ANNOTATED CLIMATOLOGICAL BIBLIOGRAPHY OF INDIA,
W70-04981 02B

ESSO PRODUCTION RESEARCH CO., HOUSTON, TEX.
METHOD FOR CALCULATING FORCES PRODUCED BY IRREGULAR WAVES,
W70-04701 08B

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO. DIV. OF POLLUTION SURVEILLANCE.
TRACE METALS IN WATERS OF THE UNITED STATES, OCTOBER 1, 1962 SEPTEMBER 30, 1967,
W70-04567 05A

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO.
PHOSPHORUS REMOVAL FROM WASTEWATER BY DIRECT DOSING OF ALUMINATE TO A TRICKLING FILTER,
W70-04806 05D

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, DALLAS, TEX.
WASTE STABILIZATION POND PRACTICES IN THE UNITED STATES,
W70-04788 05D

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, EDISON, N.J. WATER QUALITY LAB.
OIL SAMPLING TECHNIQUES (A PROGRESS REPORT).
W70-04654 05A

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, WASHINGTON, D.C.
STABILIZATION PONDS IN THE CANNING INDUSTRY,
W70-04792 05D

FLORIDA UNIV., GAINESVILLE. COASTAL ENGINEERING LAB.
QUANTITATIVE RESEARCH ON LITTORAL DRIFT AND TIDAL INLETS,
W70-05011 02L

FLORIDA UNIV., TALLAHASSEE AND CHEVRON OIL FIELD RESEARCH CO.
WAVE FORCES DATA ANALYSIS AND ENGINEERING CALCULATION METHOD,
W70-04702 08B

FLUOR CORP., LTD. LOS ANGELES, CALIF.
CONCEPTUAL DESIGN STUDY OF A ONE MILLION GALLON PER DAY NSH DESALINATION PLANT - REPLACEMENT FOR DEMONSTRATION PLANT NO. 2 AT POINT LOMA, SAN DIEGO, CALIFORNIA.
W70-04674 03A

FOREST SERVICE (USDA), CADILLAC, MICH. NORTH CENTRAL FOREST EXPERIMENT STATION.
RELATION OF SNOWPACK ACCUMULATION TO RED PINE STOCKING,
W70-04717 02C

FRESHWATER BIOLOGICAL ASSOCIATION, AMBLESIDE (ENGLAND).
PHOTOSYNTHETIC BEHAVIOUR IN STRATIFIED AND UNSTRATIFIED LAKE POPULATIONS OF A PLANKTONIC DIATOM,
W70-04814 02H

GENERAL AMERICAN TRANSPORTATION CORP., NILES, ILL. GENERAL AMERICAN RESEARCH DIV.
MATHEMATICAL MODEL OF TERTIARY TREATMENT BY LIME ADDITION,
W70-04547 05D

GENERAL MOTORS CORP., WARREN, MICH. DEPT. OF CHEMISTRY AND CONNECTICUT UNIV., STORRS. CORROSION RESEARCH LAB.
COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION,
W70-04550 08G

GEOLOGICAL SURVEY, ALBANY, N.Y.
LAKE EUTROPHICATION -- A NATURAL PROCESS,
W70-04721 05C

GEOLOGICAL SURVEY, DENVER, COLO.
BIODEGRADATION OF DODECYLGUANIDINE ACETATE (DODINE),
W70-04580 05B

HYDRAULIC TESTING AND SAMPLING OF USBM-AEC COLORADO CORE HOLE 3, RIO BLANCO COUNTY, COLORADO,
W70-04598 02F

GEOLOGICAL SURVEY, LAWRENCE, KANS.
TOTAL SEDIMENT DISCHARGE OF SELECTED STREAMS IN KANSAS, 1957 65, A COMPILATION,
W70-04560 02J

GEOLOGICAL SURVEY, LINCOLN, NEBR. WATER RESOURCES DIV.
ESTIMATE OF UNDERFLOW IN THE BIOBRARA RIVER BASIN ACROSS THE WYOMING-NEBRASKA STATE LINE,
W70-04593 02F

GEOLOGICAL SURVEY, MENLO PARK, CALIF.
ENERGY BALANCES FOR TRANSIENT WATER CRATERS,
W70-04562 01A

RELATION OF THE MANNING COEFFICIENT TO MEASURED BED ROUGHNESS IN STABLE NATURAL CHANNELS,
W70-04565 02E

URBAN EFFECTS ON WATER YIELD,
W70-04574 04C

GEOLOGICAL SURVEY, MIAMI, FLA. WATER RESOURCES DIV.
EFFECT OF PULSE RECHARGE ON THE ZONE OF DIFFUSION IN THE BISCAYNE AQUIFER,
W70-04606 02F

GEOLOGICAL SURVEY, OKLAHOMA CITY, OKLA.
RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA,
W70-04601 02F

GEOLOGICAL SURVEY, OKLAHOMA CITY, OKLA. WATER RESOURCES DIV.
SPRINGS IN THE OZARK REGION, NORTHEASTERN OKLAHOMA,
W70-04594 02F

GEOLOGICAL SURVEY, PORTLAND, OREG.
CHEMICAL QUALITY OF SURFACE WATER IN THE UMPQUA RIVER BASIN, OREGON,
W70-04722 02K

GEOLOGICAL SURVEY, SALT LAKE CITY, UTAH.
CHANGES IN CHEMICAL QUALITY OF GROUNDWATER IN THREE AREAS IN THE GREAT BASIN, UTAH,
W70-04579 02K

GEOLOGICAL SURVEY, TUCSON, ARIZ.
BEHAVIOR OF CHANNELS UPSTREAM FROM RESERVOIRS,
W70-05023 02E

GEOLOGICAL SURVEY, WASHINGTON, D.C.
TRANSFERRING STREAMFLOW CHARACTERISTICS,
W70-04554 02E

ACCURACY OF STREAMFLOW CHARACTERISTICS,
W70-04564 02E

PRECIPITATION AND BASE RUNOFF, BIG PIPE CREEK BASIN, MARYLAND,
W70-04581 02A

SENSOR DETECTION CAPABILITIES STUDY,
W70-04592 07B

FIELD MEASUREMENT OF THE INITIATION OF LARGE BED PARTICLE MOTION IN BLUE CREEK NEAR KLAMATH, CALIFORNIA,
W70-04599 02J

FLOOD OF AUGUST 1969, BON AIR QUADRANGLE, RICHMOND, VIRGINIA,
W70-04602 02E

SOME ESTIMATES OF THE THERMAL EFFECTS OF A HEATED PIPELINE IN PERMAFROST,
W70-04694 08A

URBAN SPRAWL AND FLOODING IN SOUTHERN CALIFORNIA,
W70-04832 04C

HYDROLOGIC DATA FOR RESERVOIR DESIGN,
W70-05026 07A

GEOLOGICAL SURVEY, WASHINGTON, D.C. WATER RESOURCES DIV.
THE U. S. GEOLOGICAL SURVEY URBAN WATER PROGRAM,
W70-04573 04C

GEORGIA INST. OF TECH., ATLANTA. SCHOOL OF APPLIED BIOLOGY.
I. FACTORS CAUSING POLLUTION OF RIVERS BY WASTES FROM THE TEXTILE INDUSTRY,
W70-04850 05D

HAMBURG UNIV. (WEST GERMANY). MUSEUM OF ZOOLOGY.
ESTUARIES ANALYSIS OF DEFINITIONS AND BIOLOGICAL CONSIDERATIONS,
W70-05015 02L

HARVARD UNIV., CAMBRIDGE, MASS. DEPT. OF GEOLOGICAL SCIENCES UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES. DEPT. OF GEOLOGICAL SCIENCES AND LAMONT-DOHERTY GEOLOGICAL OBSERVATORY, PALISADES, N. Y.
THE MIGRATION OF MANGANESE IN THE ARCTIC BASIN SEDIMENT,
W70-04591 02K

HARVARD UNIV., CAMBRIDGE, MASS. HARVARD DEVELOPMENT ADVISORY SERVICE.
INTEGRATING REGIONAL WATER AND POWER SYSTEMS,
W70-04988 06A

HARVEY ALUMINUM, ST. CROIX, VIRGIN ISLANDS.
TITANIUM TUBES NOW FIGHT SEA WATER,
W70-04931 08G

HAZZA ENGINEERING CO., CHICAGO, ILL.
JUDGMENT FACTORS IN INSPECTION OF DAMS,
W70-04617 08A

HAWAII UNIV., HONOLULU. WATER RESOURCES RESEARCH CENTER.
MIGRATION OF POLIOVIRUS TYPE 2 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,
W70-04688 05G

HERIOT-WATT UNIV., EDINBURGH (SCOTLAND) AND GLASGOW UNIV., (SCOTTLAND).
THE FLOW OF FLASHING WATER IN CONDUITS.
W70-04958 03A

HITTMAN ASSOCIATES, INC., COLUMBIA, MD.
FORECASTING MUNICIPAL WATER REQUIREMENTS, VOLUME I - THE MAIN II SYSTEM, VOLUME II - THE MAIN II SYSTEM USER'S MANUAL.
W70-04690 06D

MAIN C COMPUTERIZED METHODOLOGY FOR EVALUATION OF MUNICIPAL WATER CONSERVATION RESEARCH PROGRAMS, VOLUME I -- DEVELOPMENT OF THE MAIN C SYSTEM, VOLUME II -- USER'S MANUAL AND SYSTEM DOCUMENTATION.
W70-04691 06D

MAIN I A SYSTEM OF COMPUTERIZED MODELS FOR CALCULATING AND EVALUATING MUNICIPAL WATER REQUIREMENTS -- ADDENDUM TO FINAL REPORT.
W70-04692 06D

HOKKAIDO REGIONAL FISHERIES (JAPAN). RESEARCH LAB.
A NOTE ON THE THERMAL STRUCTURE OF THE EASTERN BERING SEA,
W70-04708 02L

HULL UNIV. (ENGLAND). DEPT. OF BOTANY.
INTERACTIONS BETWEEN THE RATES OF PRODUCTION OF A FRESHWATER MACROPHYTE AND PHYTOPLANKTON IN A POND,
W70-04818 02H

HYDROCOMP INTERNATIONAL, PALO ALTO, CALIF.
ANALYSIS OF WATERSHED CHANGES,
W70-04728 07C

HYDROMETEOROLOGICAL CENTRE, MOSCOW (USSR).
METHODS FOR FORECASTING OF WATER INFLOW TO RIVERS AND RESERVOIRS,
W70-05019 04A

HYDROSCIENCE, INC., LEONIA, N.J.
INDUSTRIAL WASTE TREATMENT IN AERATED LAGOONS,
W70-04781 05D

IDAHO UNIV., MOSCOW. DEPT. OF AGRICULTURAL ENGINEERING.
SIZE OF FARM IN RELATION TO IRRIGATION PUMPING COSTS,
W70-04918 03F

IIT RESEARCH INST., CHICAGO.
PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT,
W70-04546 05D

ILLINOIS STATE GEOLOGICAL SURVEY, URBANA.
PETROLEUM INDUSTRY IN ILLINOIS, 1968 PART 2. WATERFLOOD OPERATIONS,
W70-04737 06D

ILLINOIS STATE WATER SURVEY, PEORIA. WATER QUALITY SECTION.
PROBABILISTIC VARIATIONS IN ULTIMATE FIRST STAGE BOD,
W70-04711 05D

ILLINOIS UNIV., URBANA.
ECOLOGICAL CHANGES IN A POLLUTED ENVIRONMENT.
W70-04763 05D

WATER SYSTEMS MODELING,
W70-04901 06A

IMPERIAL CHEMICAL INDUSTRIES LTD., BRIXHAM (ENGLAND).
PERFORMANCE OF PLASTIC FILTER MEDIA IN INDUSTRIAL AND DOMESTIC WASTE TREATMENT,
W70-04797 05D

IMPERIAL COLL. OF SCIENCE AND TECHNOLOGY, LONDON (ENGLAND).
. . . THE ROMAN DAMS OF SUBIACO,
W70-04980 08A

IMPERIAL COLL. OF SCIENCE AND TECHOLOGY, LONDON (ENGLAND).
VISUALIZATION OF SPIRAL MOTION IN CURVED OPEN CHANNELS OF LARGE WIDTH,
W70-04553 02E

INDIANA STATE HIGHWAY COMMISSION.
DEVELOPMENT OF A HIGH-VELOCITY IMPACT TEST FOR LABORATORY COMPACTION OF GRANULAR MATERIALS,
W70-04635 08D

INSTITUT FUER WASSERWIRTSCHAFT, BERLIN (EAST GERMANY).
QUEUING THEORY AND MULTIPLE-PURPOSE RESERVOIR DESIGN,
W70-04748 04A

INSTITUTE FOR BUILDING TECHNICS, WARSAW (POLAND).
RECOMMENDATIONS FOR THE USE OF RESONANCE METHODS FOR TESTING CONCRETE,
W70-04621 08F

IOWA STATE WATER RESOURCES RESEARCH INST., AMES.
EFFECT OF CHANNEL STRAIGHTENING ON THE MOVEMENT OF FLOOD WAVES ON BOYER RIVER,
W70-04984 04A

ISRAEL METEOROLOGICAL SERVICE, BET DAGAN. DIV. OF SYNOPTIC METEOROLOGY.
FOG IN ISRAEL,
W70-04915 03B

JOHNS HOPKINS UNIV., BALTIMORE, MD.
'BALAS' ALGORITHM FOR ZONED UNIFORM TREATMENT,
W70-04796 05D

JOHNS HOPKINS UNIV., BALTIMORE, MD. CHESAPEAKE BAY INST.
TIDAL VARIATION OF THE SUSPENDED SEDIMENT SIZE DISTRIBUTION AT A STATION IN UPPER CHESAPEAKE BAY,
W70-04696 02L

OCEANIC MIXING,
W70-04697 02L

A PRELIMINARY REPORT ON THE CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT, PART 1 - CONSTANT DEPTH,
W70-04716 05B

WHAT IS AN ESTUARY PHYSICAL VIEW POINT,
W70-05014 02L

JOHNS HOPKINS UNIV., BALTIMORE, MD. SCHOOL OF HYGIENE AND PUBLIC HEALTH.
STATEMENT OF CONCERN,
W70-04584 05B

JOHNS HOPKINS UNIV., BALTIMORE, MD. AND LOUISIANA STATE UNIV., BATON ROUGE.
WASTE STABILIZATION POND PRACTICES IN THE PULP AND PAPER INDUSTRY,
W70-04794 05D

KAISER ENGINEERS, OAKLAND, CALIF.
ENGINEERING AND ECONOMIC EVALUATION STUDY OF REVERSE OSMOSIS,
W70-04889 03A

KANSAS STATE GEOLOGICAL SURVEY, LAWRENCE.
GEOLOGY AND GROUNDWATER RESOURCES OF LINN COUNTY, KANSAS,
W70-04732 02F

KANSAS STATE UNIV., MANHATTAN.
ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART I. PROCESS ANALYSIS,
W70-04681 03A

ANALYSIS AND OPTIMIZATION OF A MULTIEFFECT MULTISTAGE FLASH DISTILLATION SYSTEM - PART II. OPTIMIZATION,
W70-04682 03A

THE OPTIMAL DESIGN OF DESALINATION SYSTEMS.
W70-04957 03A

KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN, AMSTERDAM.
CHEMICAL ENVIRONMENT IN THE AQUATIC HABITAT,
W70-04821 02K

KYOTO UNIV. (JAPAN). DISASTERS PREVENTION RESEARCH INST.
VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,
W70-04595 02F

KYOTO UNIV., (JAPAN). DISASTERS PREVENTION RESEARCH INST.
MECHANICS OF THE SUCCESSIVE SALTATION OF A SAND PARTICLE ON A GRANULAR BED IN A TURBULENT STREAM,
W70-04582 02J

LABORATORY OF NUCLEAR GEOLOGY, PISA (ITALY).
ISOTOPIC ABUNDANCE OF OXYGEN AND SULFUR IN SULFATE IONS FROM RIVER WATER,
W70-04715 02K

LANCASTER UNIV., BAILRIGG (ENGLAND). DEPT. OF MATHEMATICS.
PROBABILISTIC RESERVOIR DESIGN,
W70-05031 04A

LAPORTE CHEMICALS LTD., LUTON (ENGLAND).
SOME EFFLUENT STUDIES WITH BLEACHING LIQUORS,
W70-04973 05D

LAWRENCE EXPERIMENT STATION, MASS.
A STUDY ON TREATMENT OF WOOL SCOURING LIQUORS,
W70-04743 05D

LEEDS, HILL AND JEWETT, INC., SAN FRANCISCO, CALIF.
SUPPLEMENT TO A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM,
W70-04693 10

LENINGRAD STATE UNIV. (USSR). LIMNOLOGY LAB.
ON WATER BUDGET LAKE CLASSIFICATION,
W70-04758 02H

LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
SURVEY OF CONDENSER TUBE LIFE IN SALT WATER SERVICE,
W70-04656 03A

LIVERPOOL UNIV. (ENGLAND).
A GENERALIZED PROBABILITY MODEL FOR SEQUENCES OF WET AND DRY DAYS,
W70-04695 02B

LIVERPOOL UNIV. (ENGLAND). DEPT. OF OCEANOGRAPHY.
CIRCULATION AND DIFFUSION,
W70-05004 02L

LOCKHEED-GEORGIA CO., MARIETTA.
STRUCTURAL ANALYSIS BY COMPUTER GRAPHICS,
W70-04643 08A

LOUISIANA DEPT. OF HIGHWAYS, BATON ROUGE.
PRESSUREMETER CORRELATION STUDY,
W70-04634 08D

LOUISIANA STATE UNIV., BATON ROUGE.
LAND SUBSIDENCE RELATED TO GROUNDWATER OFFTAKE IN THE NEW ORLEANS AREA,
W70-04833 04B

LOUISIANA STATE UNIV., BATON ROUGE. COASTAL STUDIES INST.
EPHEMERAL ESTUARIES OF THE DELTAIC ENVIRONMENT,
W70-05000 02L

LOUISIANA WATER RESOURCES RESEARCH INST., BATON ROUGE.
ECONOMIC ASPECTS OF GROUND-WATER BASIN CONTROL,
W70-04650 04B

THE PRESENT AND FUTURE GROUNDWATER SUPPLY OF THE BATON ROUGE AREA,
W70-04856 04B

MANHATTAN COLL., BRONX, N.Y.
ANALYSIS OF THE DISSOLVED OXYGEN VARIATION IN A FLOWING STREAM,
W70-04768 05D

MARATHON OIL CO., LITTLETON, COLO. AND SCRIPPS INSTITUTION OF OCEANOGRAPHY, LA JOLLA, CALIF.
ATMOSPHERIC DUSTS FROM THE NORTH PACIFIC - A SHORT NOTE ON A LONG-RANGE EOLIAN TRANSPORT,
W70-04707 05B

MARINE LAB., ABERDEEN (SCOTLAND) AND INDIANA UNIV., INDIANAPOLIS. DEPT. OF MICROBIOLOGY.
DISTINCTION BETWEEN BACTERIAL AND ALGAL UTILIZATION OF SOLUBLE SUBSTANCES IN THE SEA,
W70-04811 05C

MARYLAND UNIV., SOLOMONS. NATURAL RESOURCES INST.
THE SEDIMENTS OF CHESAPEAKE BAY,
W70-05005 02J

MASSACHUSETTS INST. OF TECH., CAMBRIDGE.
POTENTIAL OF PHYSICAL MODELS FOR ACHIEVING BETTER UNDERSTANDING AND EVALUATION OF WATERSHED CHANGES,
W70-04729 02A

MELPAR, FALLS CHURCH, VA.
OIL TAGGING SYSTEM STUDY, SUMMARY.
W70-04655 05A

METCALF AND EDDY, BOSTON, MASS.
NEW CONCEPTS IN AERATED LAGOON DESIGN AND OPERATION,

W70-04782 05D

MIAMI UNIV., FLA. INST. OF MARINE SCIENCE.
RATES OF SEDIMENT ACCUMULATION IN MODERN ESTUARIES,
W70-05012 02L

MICHIGAN UNIV., ANN ARBOR AND CLEMSON UNIV., S.C.
MECHANISM OF INTERFERENCE OF SURFACE ACTIVE AGENTS IN AERATION SYSTEMS,
W70-04779 05D

MICHIGAN UNIV., ANN ARBOR.
EFFECTS OF URBANIZATION ON PEAK FLOWS,
W70-04576 04C

PLANKTON DIATOM ASSEMBLANCES IN LAKE MICHIGAN,
W70-04902 05C

MIDWEST RESEARCH INST., KANSAS CITY, MO.
CORROSION IN CARBON STEEL HEAT TRANSFER SURFACES,
W70-04680 03A

MINISTRY OF AGRICULTURE, JERUSALEM (ISRAEL). HYDROLOGICAL SERVICE.
SALT WATER ENCROACHMENT IN THE COASTAL PLAIN OF ISRAEL,
W70-04613 02L

MINISTRY OF TECHNOLOGY, LONDON (ENGLAND). LAB. OF THE GOVERNMENT CHEMIST.
A ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM BY ELECTROLITIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING,
W70-04735 02K

MINNESOTA UNIV., MINNEAPOLIS.
REMOVAL OF NITROGEN BY BIOLOGICAL TREATMENT,
W70-04774 05D

MINNESOTA UNIV., MINNEAPOLIS. HEAT TRANSFER LAB.
FLOW AND HEAT TRANSFER IN THE BOUNDARY LAYER ON A CONTINUOUS MOVING SURFACE,
W70-05042 08B

HEAT TRANSFER-A REVIEW OF CURRENT LITERATURE,
W70-05043 08B

MISSOURI UNIV., COLUMBIA.
RATIONAL ULTIMATE-STRENGTH COMPOSITE-BEAM ANALYSIS,
W70-04893 08A

MISSOURI UNIV., KANSAS CITY. DEPT. OF CHEMISTRY.
DETERMINATION OF SELENIUM BY THE RING OVEN TECHNIQUE,
W70-04561 07B

MOSCOW STATE UNIV. (USSR).
HISTORY OF THE DEVELOPMENT OF LAKE ISSYK-KUL. (IN FRENCH),
W70-05021 02H

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, BOULDER, COLO.
ASSESSMENT OF ATMOSPHERIC EFFECTS OF LAKE NASSER.
W70-04756 02B

NATIONAL ENGINEERING LAB., EAST KILBRIDE (SCOTLAND).
ADVANCES IN FREE CONVECTION,
W70-05038 08B

NATIONAL INSTITUTES OF HEALTH, BETHESDA, MD. AND MARYLAND UNIV., COLLEGE PARK.
KINETICS OF ADSORPTION BY ACTIVATED CARBON FROM DILUTE AQUEOUS SOLUTION,
W70-04798 05D

NAVAL UNDERSEA RESEARCH AND DEVELOPMENT CENTER, SAN DIEGO, CALIF.
A DESCRIPTION OF THE SEASONAL THERMOCLINE CYCLE IN SHALLOW COASTAL WATER,
W70-04706 02L

NEBRASKA SOIL AND WATER CONSERVATION COMMISSION, LINCOLN.
BIG BLUE RIVER BASIN.
W70-04603 02E

NEBRASKA UNIV., LINCOLN. COLL. OF AGRICULTURE AND HOME ECONOMICS.
THE NEBRASKA WATER QUALITY SURVEY,
W70-04616 02K

NEBRASKA UNIV., LINCOLN. CONSERVATION AND SURVEY DIV.
AVAILABILITY OF GROUNDWATER FOR IRRIGATION IN CHEYENNE COUNTY, NEBRASKA,
W70-04596 02F

NETHERLANDS INST. FOR SEA RESEARCH, DEN HELDER.
SEDIMENT TRANSPORT AND SEDIMENTATION IN THE ESTUARINE ENVIRONMENT,
W70-05018 02L

NEW HAMPSHIRE UNIV., DURHAM.
NUMBERS AND TYPES OF MICROORGANISMS IN STABILIZATION POND EFFLUENTS,
W70-04819 05D

NEW MEXICO STATE UNIV., UNIVERSITY PARK.
DISPOSAL OF BRINE BY SOLAR EVAPORATION LABORATORY EXPERIMENTS,
W70-04891 05E

DISPOSAL OF BRINE BY SOLAR EVAPORATION DATA,
W70-04892 05E

NEW YORK OPERATIONS OFFICE (AEC), N. Y. HEALTH AND SAFETY LAB LAMONT-DOHERTY GEOLOGICAL OBSERVATORY, PALISADES, N. Y. WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS. AND ISOTOPES, INC., WESTWOOD, N. J.
OCEAN FALLOUT - THE CRATER LAKE EXPERIMENT,
W70-04704 05B

NEW ZEALAND WOOL INDUSTRIES RESEARCH INST., INC., DUNEDIN.
NEW ZEALAND WOOL SCOURING LIQUORS - TREATMENT AND POTASSIUM RECOVERY,
W70-04897 05D

NORGES TEKNISKE HOEGSKOLE, TRONDHEIM. DEPT. OF PORT AND OCEAN ENGINEERING.
USE OF TRACERS IN HARBOR, COASTAL AND OCEAN ENGINEERING,
W70-04551 07B

NORTH CAROLINA UNIV., CHAPEL HILL.
OPTIMUM WATER USE - A MULTIDISCIPLINARY APPROACH,
W70-04986 06A

NORTH CAROLINA UNIV., CHAPEL HILL. SCHOOL OF PUBLIC HEALTH.
MAN AND HIS URBAN ENVIRONMENT,
W70-04846 06B

ENVIRONMENTAL PLANNING WITH SPECIAL RELATIONS TO NATURAL RESOURCES,
W70-04847 06B

MANAGING THE GREAT LAKES WATER RESOURCE,
W70-04848 06B

NORTH DAKOTA STATE UNIV., FARGO. DEPT. OF SOILS.
A STUDY OF THE EFFECT OF WATER QUALITY AND MANAGEMENT ON PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED SOILS UNDER IRRIGATION,
W70-04985 03C

NORTH DAKOTA STATE UNIV., FARGO. DIV. OF NATURAL SCIENCES.
PRODUCTIVITY OF PHYTOPLANKTON AND QUANTITIES OF ZOOPLANKTON AND BOTTOM FAUNA IN RELATION TO WATER QUALITY OF LAKE ASHTABULA RESERVOIR, NORTH DAKOTA,
W70-04855 02H

NORTH TEXAS STATE UNIV., DENTON. DEPT. OF BIOLOGY.
BOTTOM FAUNA STUDIES OF THE LOWER SABINE RIVER,
W70-04808 05G

NORWEGIAN WATER RESOURCES AND ELECTRICITY BOARD, OSLO.
DIGITAL SIMULATION TECHNIQUES IN POWER SYSTEM PLANNING,
W70-04991 06A

OAK RIDGE GASEOUS DIFFUSION PLANT, TENN. AND OFFICE OF SALINE WATER, WASHINGTON, D.C.
CONCEPTUAL DESIGN STUDIES OF A DUAL-PURPOSE AND A VAPOR-COMPRESSION WATER-ONLY 750-MGD PLANT,
W70-04683 03A

OAK RIDGE NATIONAL LAB., TENN.
DEAERATORS FOR DESALINATION PLANTS.
W70-04659 03A

DYNAMICS EXPERIMENTS ON THE AMF HILLSTONE POINT FLASH EVAPORATOR,
W70-04662 03A

CONTROL OF ALKALINE SCALE USING CARBON DIOXIDE SUPPRESSION,
W70-04930 03A

CONCEPTUAL DESIGN STUDY OF A 1-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW,
W70-04939 03A

CONCEPTUAL DESIGN STUDY OF A 250 MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT,
W70-04941 03A

TESTS OF DEAERATOR AT THE FREEPORT SEAWATER DESALTING PLANT AND EVALUATION OF DISSOLVED GAS ANALYSIS.
W70-04954 03A

OAK RIDGE NATIONAL LAB., TENN. AND BECHTEL CORP., SAN FRANCISCO, CALIF.
STUDY OF 250-MGD MULTISTAGE FLASH DISTILLATION PLANT WITH TWO-LEVEL BRINE FLOW - PART I, DESIGN AND COST ESTIMATE - PART II, PRELIMINARY ENGINEERING ANALYSIS AND CAPITAL COST ESTIMATE,
W70-04951 03A

OAK RIDGE NATIONAL LAB., TENN. AND CHEMICAL SEPARATIONS CORP., OAK RIDGE, TENN.
CONTINUOUS COUNTER-CURRENT ION EXCHANGE REMOVAL OF CALCIUM FROM SEA WATER TO PREVENT SCALING OF DISTILLATION EQUIPMENT.
W70-04953 03A

OFFICE DE LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE OUTRE-MER, PARIS (FRANCE).
USING MAPS TO ESTIMATE THE TOTAL WATER STORAGE OF LITTLE RESERVOIRS OF A REGION. (IN FRENCH),
W70-05030 02E

OFFICE OF SALINE WATER, WASHINGTON, D.C.
SEA WATER DESALINATION BY THE FALLING-FILM PROCESS,
W70-04677 03A

OFFICE OF SALINE WATER, WASHINGTON, D.C. AND OAK RIDGE NATIONAL LAB., TENN.
DEVELOPMENT OF TECHNOLOGY APPLICABLE TO 50 MGD AND LARGER SEAWATER DISTILLATION PLANTS,
W70-04666 03A

OFFICE OF THE CHIEF OF ENGINEERS (ARMY), WASHINGTON, D.C.

CIVIL WORKS DIRECTORATE.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION-VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04827 06B

OKLAHOMA STATE UNIV., STILLWATER.
A MATHEMATICAL MODEL OF AN EXISTING MUNICIPAL WELL FIELD,
W70-04619 02F

EFFECTS OF REMOLDING ON THE PROPERTIES OF A LATERITIC SOIL,
W70-04632 08D

ONTARIO DEPT. OF AGRICULTURE AND FOOD, GUELPH. PROVINCIAL PESTICIDE RESIDUE TESTING LAB.
HERBICIDAL PROPERTIES OF SUBSTITUTED INDANS,
W70-04817 05B

ONTARIO WATER RESOURCES COMMISSION, TORONTO. DIV. OF LABS.
YIELDS AND SOURCES OF NITROGEN FROM SEVERAL LAKE ONTARIO WATERSHEDS,
W70-04979 05B

OPEN LANDS PROJECT, CHICAGO, ILL.
TO PREVENT AN UNNATURAL DEATH.
W70-04898 05C

OREGON STATE UNIV., CORVALLIS. DEPT. OF OCEANOGRAPHY.
AN OPTICAL AND HYDROGRAPHIC STUDY OF A TEMPERATURE INVERSION OFF OREGON DURING UPWELLING,
W70-04709 02L

SEDIMENTS OF YAQUINA BAY, OREGON,
W70-05002 02J

OREGON STATE UNIV., CORVALLIS. SCHOOL OF FORESTRY AND OREGON AGRICULTURAL EXPERIMENT STATION, CORVALLIS.
EFFECT OF DROUGHT UPON RATES OF PHOTOSYNTHESIS, RESPIRATION, AND TRANSPIRATION OF SEEDLINGS OF TWO ECOTYPES OF DOUGLAS-FIR,
W70-04909 02I

OREGON STATE UNIV., CORVALLIS. SCHOOL OF FORESTRY.
PREDICTING THE EFFECT OF CLEARCUTTING ON STREAM TEMPERATURE,
W70-04556 04C

PARIS UNIV. (FRANCE). INSTITUT DE GEOGRAPHIE.
ORIGIN OF SEDIMENTS IN ESTUARIES,
W70-05013 02L

PENNSYLVANIA UNIV., PHILADELPHIA. DEPT. OF GEOLOGY.
COMPARISON OF RECENT AND ANCIENT TIDAL FLAT AND ESTUARINE SEDIMENTS,
W70-05010 02J

PUBLIC HEALTH AND EPIDEMIOLOGY STATION, MISKOLC (HUNGARY) AND PUBLIC HEALTH INST., BUDAPEST (HUNGARY).
INVESTIGATIONS ON WATER QUALITY AT ARTIFICIAL RECHARGE OF GROUNDWATER,
W70-04605 04B

PUBLIC HEALTH SERVICE, CINCINATTI, OHIO. DIV. OF WATER SUPPLY AND POLLUTION CONTROL.
NOTES ON ESTUARINE POLLUTION WITH EMPHASIS ON THE LOUISANA GULF COAST,
W70-05006 05B

PUERTO RICO UNIV., MAYAGUEZ. WATER RESOURCES RESEARCH INST.
QUANTITATIVE ANALYSIS OF RESIDENTIAL WATER-USE PATTERNS IN MAYAGUEZ, PUERTO RICO,
W70-04830 06D

PURDUE UNIV., LAFAYETTE, INC.
PILOT INVESTIGATION OF STARCH-GLUTEN WASTE TREATMENT,
W70-04803 05D

PURDUE UNIV., LAFAYETTE, IND.
SODIUM HYDROXIDE RECOVERY IN THE TEXTILE INDUSTRY,
W70-04637 05D

TREATMENT STUDIES OF COMBINED TEXTILE AND DOMESTIC WASTES,
W70-04795 05A

PURDUE UNIV., LAFAYETTE, IND. ENGINEERING EXTENSION.
TREATMENT OF WOOL WASTES,
W70-04626 05D

PURDUE UNIV., LAFAYETTE, IND. SCHOOL OF MECHANICAL ENGINEERING.
RADIATION TRANSFER AND INTERACTION OF CONVECTION WITH RADIATION HEAT TRANSFER,
W70-05035 08B

REDITELSTVI VODNICH TOKU, PRAGUE (CZECHOSLOVAKIA).
DETERMINATION OF THE ECONOMIC CAPACITY OF STORAGE RESERVOIRS,
W70-05033 04A

RESEARCH INST. FOR GEOLOGY AND BIOLOGY. WILHELMSHAVEN (WEST GERMANY).
LAYERED SEDIMENTS OF TIDAL FLATS, BEACHES, AND SHELF BOTTOMS OF THE NORTH SEA,
W70-04994 02J

RESEARCH INST. FOR WATER RESOURCES DEVELOPMENT, BUDAPEST (HUNGARY).
CHANGES OF THE WATER LEVEL OF LAKE BALATON FROM THE NEOLITHIC AGE UP TO THE PRESENT TIME,
W70-04755 02H

SOME METHODOLOGICAL PROBLEMS OF INVENTORIES ON LAKES,
W70-04757 02H

RESEARCH TRIANGEL INST., DURHAM, N. C.
ANALYSIS, DATA CORRELATION, AND OPTIMIZATION OF THE VAPOR REHEAT LIQUID-LIQUID HEAT EXCHANGE PROCESS,
W70-04940 03A

RESOURCES FOR THE FUTURE, INC., WASHINGTON, D.C.
ECONOMICS OF ARTIFICIAL RECHARGE FOR MUNICIPAL WATER SUPPLY,
W70-04614 04B

WATER RESOURCES VALUES,
W70-04762 05D

RESOURCES FOR THE FUTURE, INC., WASHINGTON, D.C. AND CALIFORNIA UNIV., BERKELEY.
BIOLOGICAL AND PHYSICAL RESPONSES IN A FRESHWATER DISSOLVED OXIGEN MODEL,
W70-04771 05D

RICE UNIV., HOUSTON, TEX.
CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,
W70-04773 05D

ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO. CINCINNATI WATER RESEARCH LAB. AND CINCINNATI UNIV., OHIO. DEPT. OF MATHEMATICS.
CHEMICAL REACTION BETWEEN RECHARGE WATER AND AQUIFER WATER,
W70-04615 02K

ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO. CINCINNATI WATER RESEARCH LAB.
LIME CLARIFICATION, RECOVERY, REUSE, AND SLUDGE DEWATERING CHARACTERISTICS,
W70-04801 05D

ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO. MICROBIOLOGY SECTION.
CONTROL OF SULFATE-REDUCING BACTERIA,
W70-04813 05G

ROBERT A. TAFT WATER RESEARCH CENTER, CINCINNATI, OHIO. ADVANCED WASTE TREATMENT RESEARCH LAB.
DILUTE SOLUTION REACTIONS OF THE NITRATE ION AS APPLIED TO WATER RECLAMATION,
W70-04652 05D

ROYAL DANISH SCHOOL OF PHARMACY, COPENHAGEN. DEPT. OF BOTANY.
THE ADAPTATION OF PLANKTON ALGAE. III. WITH SPECIAL CONSIDERATION OF THE IMPORTANCE IN NATURE,
W70-04809 02H

RUTGERS - THE STATE UNIV., NEW BRUNSWICK, N.J.
EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES. PART I,
W70-04684 05C

RUTGERS - THE STATE UNIV., NEW BRUNSWICK, N.J. DEPT. OF METEOROLOGY.
A STATISTICAL SIMULATION TECHNIQUE FOR NORTHERN NEW JERSEY MONTHLY PRECIPITATION,
W70-04718 02B

FORECASTING SNOW AND RAIN FOR THE NEW YORK CITY AREA USING THE METHOD OF ORDERED STATISTICS,
W70-04720 02B

RUTGERS - THE STATE UNIV., NEW BRUNSWICK, N.J. WATER RESOURCES RESEARCH INST.
WATER QUALITY AND VALUE OF HOMESITES ON THE ROCKAWAY RIVER, N.J.,
W70-04686 06B

SACRAMENTO STATE COLL., CALIF. DEPT. OF CIVIL ENGINEERING.
COMPLEMENTARY-COMPETITIVE ASPECTS OF WATER STORAGE (AN ENGINEERING-ECONOMIC APPROACH TO EVALUATE THE EXTENT AND MAGNITUDE OF THE COMPLEMENTARY AND COMPETITIVE ASPECTS OF WATER STORAGE FOR WATER QUALITY CONTROL),
W70-04653 05G

SALT RIVER VALLEY WATER USERS' ASSOCIATION, PHOENIX, ARIZ.
MANIPULATING VEGETATION FOR WATER CONSERVATION,
W70-04916 03B

SAN JOSE STATE COLL., CALIF.
INVESTIGATION OF A WOOD CURING WASTE,
W70-04805 05D

SCHOELL AND MADSON, INC., HOPKINS, MINN.
EUTROPHICATION TESTING PROGRAM FOR MINNESOTA'S 'SKY BLUE WATERS',
W70-04810 02H

SHELL DEVELOPMENT CO., HOUSTON, TEX.
ANALYSIS OF WAVE FORCE DATA,
W70-04700 08B

SOCIETE GRENOBLOISE D'ETUDE ET D'APPLICATIONS HYDRAULIQUES (FRANCE).
ON THE SUBJECT OF A FLOOD PROPAGATION COMPUTATION METHOD (MUSKINGUM METHOD),
W70-04590 02E

SOIL CONSERVATION SERVICE, EAST LANSING, MICH.
SOIL EROSION IN THE DETROIT METROPOLITAN AREA,
W70-04557 02J

SOIL CONSERVATION SERVICE, FORT WORTH, TEX. ENGINEERING AND WATERSHED PLANNING UNIT.
EFFECTS OF SMALL STRUCTURES ON PEAK FLOW,
W70-04571 04A

SOIL CONSERVATION SERVICE, IOWA CITY, IOWA AND IOWA STATE WATER RESOURCES RESEARCH INST., AMES.
HYDROLOGIC SYSTEM RELATED TO GEOLOGY AND SOILS, FOUR MILE CREEK AREA, TAMA COUNTY, IOWA,
W70-04545 02E

SOIL CONSERVATION SERVICE, PORTLAND, OREG. ENGINEERING AND WATERSHED PLANNING UNIT.
SOME VARIABLES WHICH INFLUENCE RATES OF RESERVOIR SEDIMENTATION IN WESTERN UNITED STATES,
W70-05024 02J

SOIL CONSERVATION SERVICE, WASHINGTON, D.C.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04825 06B

SOIL CONSERVATION SERVICE, WASHINGTON, D.C. ENGINEERING DIV.
SEDIMENT DESIGN REQUIREMENT FOR SMALL RESERVOIRS,
W70-05025 02J

SOIL RESEARCH LABS., AMRITSAR (INDIA).
CHEMISTRY OF MANGANESE IN NATURAL WATERS,
W70-04558 02K

SOUTHERN ILLINOIS UNIV., CARBONDALE. DEPT. OF BIOLOGY.
EARTH, AIR, WATER,
W70-04585 05B

SPENCE (PETER) AND SONS LTD., WIDNES (ENGLAND).
PROBLEMS OF EFFLUENT DISPOSAL,
W70-04963 05D

LEGAL AND PRACTICAL PROBLEMS OF EFFLUENT DISPOSAL,
W70-04976 05D

STANFORD UNIV., CALIF.
ANAEROBIC TREATMENT OF SOLUBLE WASTES,
W70-04783 05D

STANFORD UNIV., CALIF. DEPT. OF CIVIL ENGINEERING.
AN EVALUATION OF THE DECISION PROCESS IN WATER RESOURCE PROJECT DESIGN,
W70-04548 06A

STATE HYDROLOGICAL INST. (USSR).
BANK FORMATION OF NEWLY ESTABLISHED RESERVOIRS,
W70-05022 04A

STATE INST. OF HYDROLOGY AND METEOROLOGY, KRAKOW (POLAND).
DETERMINATION OF SILTING IN WATER BASIN BY MEANS OF SOLID TRANSPORT BALANCE, (IN FRENCH),
W70-04751 02J

EMPIRICAL METHOD FOR DETERMINATION OF STORAGE RESERVOIR CAPACITY,
W70-04759 04A

STEARNS-ROGER CORP., DENVER, COLO.
DEVELOPMENT REPORT NO. 6, SALINE WATER CONVERSION DEMONSTRATION PLANT NO. 1, FREEPORT, TEXAS.
W70-04668 03A

DEVELOPMENT REPORT NO. 7, SALINE WATER CONVERSION TEST BED PLANT, FREEPORT, TEXAS.
W70-04669 03A

OPERATING EXPERIENCES AT THE LTV DEMONSTRATION PLANT, FREEPORT, TEXAS,
W70-04952 03A

STOCKHOLM UNIV. (SWEDEN). DEPT. OF ZOOLOGY AND STOCKHOLM UNIV. (SWEDEN). ASKO LAB.
SEASONAL AND VERTICAL DISTRIBUTION OF THE ZOOPLANKTON IN THE ASKO AREA (NORTHERN BALTIC PROPER) IN RELATION TO HYDROGRAPHICAL CONDITIONS,
W70-04816 05C

STRUTHERS ENERGY SYSTEMS, INC., WARREN, PA. AND PRATT AND WHITNEY AIRCRAFT, EAST HARTFORD, CONN.
DESIGN AND ECONOMIC STUDY OF A GAS TURBINE POWERED VAPOR COMPRESSION PLANT FOR EVAPORATION OF SEAWATER,
W70-04933 03A

SWARTHMORE COLL., PA. DEPT. OF PHYSICS, AND WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS.
SALINITY MEASUREMENTS IN ESTUARIES,
W70-04999 02L

SWINDELL-DRESSLER CO., PITTSBURGH, PA.
APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 1. EVALUATION OF THE LITERATURE, AND PHASE 2. ECONOMIC EFFECT OF DESIGN VARIABLES,
W70-04548 05D

APPRAISAL OF GRANULAR CARBON CONTACTING PHASE 3. ENGINEERING DESIGN,
W70-04549 05D

SYRACUSE UNIV., N.Y.
THE OPTIMAL DESIGN OF MULTI-STAGE FLASH EVAPORATORS BY DYNAMIC PROGRAMMING,
W70-04943 03A

SYSTEM DEVELOPMENT CORP., SANTA MONICA, CALIF.
VOLUME TWO-TECHNICAL DEVELOPMENT PLAN, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT.
W70-04600 7C

TECHNION - ISRAEL INST. OF TECH., HAIFA AND WATER PLANNING FOR ISRAEL LTD., TEL AVIV.
EXTRA-DEEP PONDS,
W70-04790 05D

TECHNION-ISRAEL INST. OF TECH., HAIFA. SANITARY ENGINEERING LAB. AND AGRICULTURAL RESEARCH SERVICE, BUSHLAND, TEX. SOUTHERN PLAINS BRANCH.
CLARIFICATION OF TURBID WATER WITH POLIELECTROLYTES FOR RECHARGE THROUGH WELLS,
W70-04609 04B

TECHNISCHE HOCHSCHULE, VIENNA (AUSTRIA).
AERATION DEVELOPMENTS IN EUROPE,
W70-04778 05D

TECHNISCHE HOGESCHOOL, DELFT (NETHERLANDS).
EXPERIENCES WITH LARGE SEAWATER FLASH EVAPORATORS,
W70-04934 03A

TENNESSEE UNIV., KNOXVILLE.
NUCLEAR DESALINATION PLANT DYNAMICS - MODELING AND ANALYSIS OF A MULTISTAGE FLASH EVAPORATOR,
W70-04663 03A

AN EFFICIENT, COMPUTER-ORIENTED METHOD FOR STABILITY ANALYSIS OF LARGE MULTIVARIABLE SYSTEMS,
W70-04673 03A

TEXAS A AND M UNIV., COLLEGE STATION. WATER RESOURCES INST.
WATER TRANSFER FROM SOIL TO THE ATMOSPHERE AS RELATED TO CLIMATE AND SOIL PROPERTIES,
W70-04685 02G

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY,
W70-04687 02L

EVALUATION OF RESOURCE USE AND ECONOMIC EFFECTS DUE TO IRRIGATION WATER AVAILABILITY IN TEXAS,
W70-04983 06B

TEXAS TECH UNIV., LUBBOCK.
IRRIGATION IN THE TEXAS HIGH PLAINS AND THE TEXAS WATER PLAN,
W70-04618 03F

TEXAS UNIV., AUSTIN, AND TEXAS TECH UNIV., LUBBOCK.
APPLICATION OF CONTINUOUS ACCOUNTING TECHNIQUES TO EVALUATE THE EFFECTS OF SMALL STRUCTURES ON MUKEWATER CREEK, TEXAS,
W70-04726 04C

TEXAS UNIV., AUSTIN AND LOUISIANA POLYTECHNIC INST., RUSTON.
RELATIONSHIP BETWEEN THE PHYSICAL AND BIOLOGICAL ENVIRONMENTS - PHYSICAL EXCHANGE,
W70-04769 05D

TEXAS UNIV., AUSTIN.
ADVANCES IN WATER QUALITY IMPROVEMENT-WATER RESOURCES SYMPOSIUM NO. 1.
W70-04761 05D

BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION PROBLEMS IN FRESHWATER,
W70-04765 05D

ECOLOGICAL ASPECTS OF STREAM POLLUTION,
W70-04767 05D

NEW CONCEPTS IN OXYGEN TRANSFER AND AERATION,
W70-04777 05D

NEW DEVELOPMENTS IN ANAEROBIC DIGESTION OF SLUDGES,
W70-04784 05D

BASIS FOR WASTE STABILIZATION POND DESIGNS,
W70-04786 05D

TEXAS UNIV., AUSTIN. DEPT. OF CIVIL ENGINEERING.
EFFECTS OF WATERSHED CHANGES ON STREAMFLOW,
W70-04723 04C

TEXAS UNIV., AUSTIN. ENVIRONMENTAL HEALTH ENGINEERING RESEARCH LAB.
URBAN EFFECTS ON QUALITY OF STREAMFLOW,
W70-04727 04C

NITROGEN RELATIONSHIPS IN BIOLOGICAL TREATMENT PROCESSES--I. NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,
W70-04896 05D

TEXAS UNIV., PORT ARANSAS. INST. OF MARINE SCIENCE.
BIOLOGICAL RESPONSES TO NUTRIENTS-EUTROPHICATION SALINE WATER CONSIDERATIONS,
W70-04766 05D

TEXAS WATER DEVELOPMENT BOARD, AUSTIN AND INTERNATIONAL BOUNDARY AND WATER COMMISSION, EL PASO, TEXAS.
INFORMATIONAL NEEDS ON CHANGES IN RURAL WATERSHEDS AND THEIR RELATIONSHIPS TO PLANNING ACTIVITIES,
W70-04724 04C

TINGEY-HOSS LTD.
CURRENT PRACTICE IN SOLVENT SCOURING AND ITS FUTURE DEVELOPMENTS,
W70-04960 05D

TITANIUM METALS CORP. OF AMERICA, WEST CALDWELL, N.J.
CORROSION RESISTANCE OF TITANIUM AND ITS ALLOYS IN PRIMARY WATER AND HOT BRINE ENVIRONMENTS,

W70-04667 08G

TORONTO UNIV. (ONTARIO). DEPT. OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY.
TURBULENT HEAT TRANSFER FROM SMOOTH AND ROUGH SURFACES,
W70-05041 08B

TORONTO UNIV., (ONTARIO). DEPT. OF MECHANICAL ENGINEERING.
CERTAINTY OF STREAM-FLOW CONTROL WITHIN A LIMITED PERIOD OF TIME,
W70-04749 04A

TRACOR, INC., AUSTIN, TEX. AND TEXAS UNIV., COLL. OF ENGINEERING.
URBAN EFFECTS ON THE UNIT HYDROGRAPH,
W70-04577 04C

TRANSDANUBIAN WATER AUTHORITY, SZEKESFEHERVAR (HUNGARY).
STORAGE OF THE FLOODS OF SMALL WATERCOURSES, (IN FRENCH),
W70-04747 04A

TRENT RIVER BOARD (GT. BRIT.).
TRADE EFFLUENT CONTROL IN THE CARPET INDUSTRY,
W70-04625 05D

TURNER, COLLIE AND BRADEN CO., INC., HOUSTON, TEX.
EXPERIENCE WITH THE EVALUATION OF URBAN EFFECTS FOR DRAINAGE DESIGN,
W70-04578 04C

UNION CARBIDE CORP., OAK RIDGE, TENN.
THE APPLICATION OF A DIGITAL COMPUTER TO MECHANICAL TESTING,
W70-04624 08G

UNIVERSITY COLL., LONDON (ENGLAND).
DEFINED VELOCITY GRADIENT MODEL FLOCCULATOR,
W70-04802 05D

UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES. DEPT. OF GEOLOGICAL SCIENCES.
CONTRASTS IN COASTAL BAY SEDIMENTS ON THE GULF AND PACIFIC OCASTS,
W70-05007 02J

UTAH WATER RESEARCH LAB., LOGAN.
MODELING THE RUNOFF CHARACTERISTICS OF AN URBAN WATERSHED BY MEANS OF AN ANALOG COMPUTER,
W70-04575 04C

VIRGINIA INST. OF MARINE SCIENCE, GLOUCESTER POINT AND VIRGINIA UNIV., CHARLOTTESVILLE. DEPT. OF GEOLOGY.
SEDIMENTARY PATTERNS OF MICROFAUNA IN A COASTAL PLAIN ESTUARY,
W70-05009 02L

WALLACE AND TIERNAN, INC., BELLEVILLE, N.J.
APPLICATION OF CHLORINE AND TREATMENT OF TEXTILES WASTES,
W70-04974 05D

WARSAW UNIV. (POLAND). DEPT. OF PHYSICAL GEOGRAPHY.
HISTORY OF LAKES ON THE YOUNG-GLACIAL AREAS OF THE NORTH-EASTERN POLAND,
W70-04754 02H

WASHINGTON UNIV., SEATTLE. COLL. OF FOREST RESOURCES.
EFFECTS OF FOREST COVER MANIPULATION ON WATER YIELD AS STUDIED BY AN ELECTRIC ANALOG,
W70-04854 03B

WASHINGTON UNIV., SEATTLE. DEPT. OF OCEANOGRAPHY.
CONCENTRATIONS OF MINOR ELEMENTS IN DIATOMACEOUS SEDIMENTS OF A STAGNANT FJORD,
W70-04996 02L

SOME ASPECTS OF THE DYNAMICS OF CIRCULATION IN FJORDS,
W70-04997 02L

SALT BALANCE AND CIRCULATION IN PARTIALLY MIXED ESTUARIES,
W70-05017 02L

WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS,
W70-04775 05D

WATER RESEARCH ASSOCIATION, MEDMENHAM (ENGLAND).
GENERALIZED EVALUATIONS OF THE PROBABILITY OF RESERVOIR EMPTINESS WITH GAUSSIAN OR GAMMA INPUTS FOR THE TWO-SEASON CASE,
W70-05020 04A

APPLICATIONS OF TWO-SEASON STATISTICS TO RESERVOIR YIELD CALCULATION,
W70-05029 04A

WATER RESOURCE BOARD, READING (ENGLAND). RESEARCH DIV.
THE OPERATION OF REGULATING RESERVOIRS,
W70-04746 04A

WATER RESOURCES BOARD, READING (ENGLAND). GROUNDWATER DIV.
THE GROUNDWATER HYDROLOGY OF THE LINCOLNSHIRE LIMESTONE,
W70-04733 02F

WATER RESOURCES COUNCIL, WASHINGTON, D.C.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION - VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04826 06B

ALTERNATIVE INSTITUTIONAL ARRANGEMENTS FOR MANAGING RIVER BASIN OPERATIONS.
W70-04834 06B

WATERLOO UNIV. (ONTARIO).
WASTE STABILIZATION POND PRACTICES IN CANADA,
W70-04789 05D

WEIR WESTGARTH LTD., LONDON (ENGLAND).
CHAMBER GEOMETRY IN MULTI-STAGE FLASH EVAPORATOR - SEPARATOR STUDIES.
W70-04944 03A

WESTERN AGRICULTURAL ECONOMICS RESEARCH COUNCIL, DENVER, COLO. COMMITTEE ON THE ECONOMICS OF WATER RESOURCES DEVELOPMENT.
THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION PART I. VIEWS FROM THE ACADEMY.
W70-04903 06C

THE DISCOUNT RATE IN PUBLIC INVESTMENT EVALUATION, PART II VIEWS FROM THE FEDERAL GOVERNMENT A PANEL DISCUSSION,
W70-04904 06C

WESTERN STATES WATER COUNCIL.
THE REGIONAL INTEREST IN WATERSHED MANAGEMENT,
W70-04913 04C

WESTINGHOUSE ELECTRIC CORP., PHILADELPHIA, PA.
OPERATING EXPERIENCE AT THE MULTI-STAGE FLASH DEMONSTRATION PLANT, POINT LOMA, CALIFORNIA,
W70-04679 03A

DESIGN, OPERATION, AND RESULTS OF THE LARGEST FLASH-TYPE SEAWATER CONVERSION PLANT AND ITS EFFECT ON FUTURE CONVERSION PLANTS.
W70-04950 03A

WINDSOR UNIV. (ONTARIO). DEPT. OF CIVIL ENGINEERING AND COLORADO STATE UNIV., FORT COLLINS. DEPT. OF CIVIL ENGINEERING.
DRAINAGE OF A SALINE-WATER AQUIFER RECHARGED BY FRESH WATER,
W70-04612 04B

WISCONSIN UNIV., MADISON.
AIRPHOTO INTERPRETATION OF FLOOD PLAIN SOILS,
W70-04630 08D

FLOCCULATION PHENOMENA IN BIOLOGICAL SYSTEMS,
W70-04780 05D

SHORELAND CORRIDOR REGULATIONS TO PROTECT LAKES,
W70-04820 02H

WISCONSIN UNIV., MADISON. DEPT. OF CIVIL ENGINEERING.
PROBABILITY THEORY AS AN AID TO RESEARCH PLANNING,
W70-04989 06A

WISCONSIN UNIV., MADISON. DEPT. OF METEOROLOGY.
SOME OBSERVATIONS OF CURRENTS IN THE HYPOLIMNION OF LAKE MENDOTA,
W70-04812 02H

WISCONSIN UNIV., MADISON. WATER CHEMISTRY LAB.
AUTOMATIC METHODS FOR THE ANALYSIS OF NATURAL WATERS,
W70-04822 07B

WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS AND WILLIAMS COLL., WILLIAMSTOWN, MASS. DEPT. OF GEOLOGY.
SUSPENDED MATTER IN SURFACE WATERS OF THE ATLANTIC CONTINENTAL MARGIN FROM CAPE COD TO THE FLORIDA KEYS,
W70-04552 02J

WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS.
PHYTOPLANKTON NUTRIENTS IN ESTUARIES,
W70-04993 02L

THE ONTOGENY OF A SALT MARSH ESTUARY,
W70-04998 02L

ESTUARIES AND LAGOONS IN RELATION TO CONTINENTAL SHELVES,
W70-05016 02L

YALE UNIV., NEW HAVEN, CONN. DEPT. OF GEOLOGY.
DIAGENESIS OF IRON SULFIDE IN RECENT MARINE SEDIMENTS,
W70-05008 02K

ZUIDER ZEE WORKS (NETHERLANDS). HYDROLOGY SECTION.
THE IJSSEL LAKE AS A MULTI-PURPOSE RESERVOIR,
W70-05027 08A

ACCESSION NUMBER INDEX

06A	W70-04544	05D	W70-04625	02L	W70-04706	05D	W70-04787
02E	W70-04545	05D	W70-04626	05B	W70-04707	05D	W70-04788
05D	W70-04546	08F	W70-04627	02L	W70-04708	05D	W70-04789
05D	W70-04547	08F	W70-04628	02L	W70-04709	05D	W70-04790
05D	W70-04548	08F	W70-04629	02K	W70-04710	05D	W70-04791
05D	W70-04549	08D	W70-04630	05D	W70-04711	05D	W70-04792
08G	W70-04550	08D	W70-04631	05D	W70-04712	05D	W70-04793
07B	W70-04551	08D	W70-04632	04A	W70-04713	05D	W70-04794
02J	W70-04552	08D	W70-04633	05A	W70-04714	05A	W70-04795
02E	W70-04553	08D	W70-04634	02K	W70-04715	05D	W70-04796
02E	W70-04554	08D	W70-04635	05B	W70-04716	05D	W70-04797
04A	W70-04555	08F	W70-04636	02C	W70-04717	05D	W70-04798
04C	W70-04556	05D	W70-04637	02B	W70-04718	05D	W70-04799
02J	W70-04557	03F	W70-04638	02B	W70-04719	05D	W70-04800
02K	W70-04558	03F	W70-04639	02B	W70-04720	05D	W70-04801
10	W70-04559	08C	W70-04640	05C	W70-04721	05D	W70-04802
02J	W70-04560	08G	W70-04641	02K	W70-04722	05D	W70-04803
07B	W70-04561	08C	W70-04642	04C	W70-04723	05D	W70-04804
01A	W70-04562	08A	W70-04643	04C	W70-04724	05D	W70-04805
02A	W70-04563	08D	W70-04644	04D	W70-04725	05D	W70-04806
02E	W70-04564	08C	W70-04645	04C	W70-04726	05D	W70-04807
02E	W70-04565	08C	W70-04646	04C	W70-04727	05G	W70-04808
02L	W70-04566	03A	W70-04647	07C	W70-04728	02H	W70-04809
05A	W70-04567	05D	W70-04648	02A	W70-04729	02H	W70-04810
02L	W70-04568	03A	W70-04649	03F	W70-04730	05C	W70-04811
02K	W70-04569	04B	W70-04650	02J	W70-04731	02H	W70-04812
02K	W70-04570	07C	W70-04651	02F	W70-04732	05G	W70-04813
04A	W70-04571	05D	W70-04652	02F	W70-04733	02H	W70-04814
04D	W70-04572	05G	W70-04653	02B	W70-04734	05C	W70-04815
04C	W70-04573	05A	W70-04654	02K	W70-04735	05C	W70-04816
04C	W70-04574	05A	W70-04655	02K	W70-04736	05B	W70-04817
04C	W70-04575	03A	W70-04656	06D	W70-04737	02H	W70-04818
04C	W70-04576	03A	W70-04657	04A	W70-04738	05D	W70-04819
04C	W70-04577	03A	W70-04658	02C	W70-04739	02H	W70-04820
04C	W70-04578	03A	W70-04659	03D	W70-04740	02K	W70-04821
02K	W70-04579	03A	W70-04660	02C	W70-04741	07B	W70-04822
05B	W70-04580	03A	W70-04661	02C	W70-04742	07B	W70-04823
02A	W70-04581	03A	W70-04662	05D	W70-04743	06B	W70-04824
02J	W70-04582	03A	W70-04663	04A	W70-04744	06B	W70-04825
05G	W70-04583	03A	W70-04664	04A	W70-04745	06B	W70-04826
05B	W70-04584	03A	W70-04665	04A	W70-04746	06B	W70-04827
05B	W70-04585	03A	W70-04666	04A	W70-04747	06B	W70-04828
05D	W70-04586	08G	W70-04667	04A	W70-04748	06B	W70-04829
05D	W70-04587	03A	W70-04668	04A	W70-04749	06D	W70-04830
05D	W70-04588	03A	W70-04669	04A	W70-04750	05D	W70-04831
05G	W70-04589	08C	W70-04670	02J	W70-04751	04C	W70-04832
02E	W70-04590	03A	W70-04671	02J	W70-04752	04B	W70-04833
02K	W70-04591	03A	W70-04672	02J	W70-04753	06B	W70-04834
07B	W70-04592	03A	W70-04673	02H	W70-04754	06A	W70-04835
02F	W70-04593	03A	W70-04674	02H	W70-04755	06A	W70-04836
02F	W70-04594	03A	W70-04675	02B	W70-04756	06A	W70-04837
02F	W70-04595	03A	W70-04676	02H	W70-04757	06A	W70-04838
02F	W70-04596	03A	W70-04677	02H	W70-04758	06A	W70-04839
02H	W70-04597	03A	W70-04678	04A	W70-04759	06A	W70-04840
02F	W70-04598	03A	W70-04679	06B	W70-04760	06A	W70-04841
02J	W70-04599	03A	W70-04680	05D	W70-04761	06A	W70-04842
7C	W70-04600	03A	W70-04681	05D	W70-04762	06A	W70-04843
02F	W70-04601	03A	W70-04682	05D	W70-04763	06A	W70-04844
02E	W70-04602	03A	W70-04683	05D	W70-04764	06A	W70-04845
02E	W70-04603	05C	W70-04684	05D	W70-04765	06B	W70-04846
04B	W70-04604	02G	W70-04685	05D	W70-04766	06B	W70-04847
04B	W70-04605	06B	W70-04686	05D	W70-04767	06B	W70-04848
02F	W70-04606	02L	W70-04687	05D	W70-04768	05D	W70-04849
02G	W70-04607	05G	W70-04688	05D	W70-04769	05D	W70-04850
04B	W70-04608	06F	W70-04689	05D	W70-04770	05D	W70-04851
04B	W70-04609	06D	W70-04690	05D	W70-04771	05D	W70-04852
04B	W70-04610	06D	W70-04691	05D	W70-04772	05D	W70-04853
04B	W70-04611	06D	W70-04692	05D	W70-04773	03B	W70-04854
04B	W70-04612	10	W70-04693	05D	W70-04774	02H	W70-04855
02L	W70-04613	08A	W70-04694	05D	W70-04775	04B	W70-04856
04B	W70-04614	02B	W70-04695	05D	W70-04776	06E	W70-04857
02K	W70-04615	02L	W70-04696	05D	W70-04777	06E	W70-04858
02K	W70-04616	02L	W70-04697	05D	W70-04778	06E	W70-04859
08A	W70-04617	02B	W70-04698	05D	W70-04779	06E	W70-04860
03F	W70-04618	08B	W70-04699	05D	W70-04780	06E	W70-04861
02F	W70-04619	08B	W70-04700	05D	W70-04781	06E	W70-04862
08F	W70-04620	08B	W70-04701	05D	W70-04782	06E	W70-04863
08F	W70-04621	08B	W70-04702	05D	W70-04783	06E	W70-04864
08C	W70-04622	02C	W70-04703	05D	W70-04784	06E	W70-04865
08C	W70-04623	05B	W70-04704	05D	W70-04785	06E	W70-04866
08G	W70-04624	05B	W70-04705	05D	W70-04786	06E	W70-04867

ACCESSION NUMBER INDEX

06E	W70-04868	02I	W70-04912	03A	W70-04956	02L	W70-05000
06E	W70-04869	04C	W70-04913	03A	W70-04957	02L	W70-05001
06E	W70-04870	03B	W70-04914	03A	W70-04958	02J	W70-05002
06E	W70-04871	03B	W70-04915	03A	W70-04959	02L	W70-05003
06E	W70-04872	03B	W70-04916	05D	W70-04960	02L	W70-05004
06E	W70-04873	03B	W70-04917	05D	W70-04961	02J	W70-05005
06E	W70-04874	03F	W70-04918	05D	W70-04962	05B	W70-05006
06E	W70-04875	02D	W70-04919	05D	W70-04963	02J	W70-05007
06E	W70-04876	02D	W70-04920	05D	W70-04964	02K	W70-05008
06E	W70-04877	02D	W70-04921	05D	W70-04965	02L	W70-05009
06E	W70-04878	02D	W70-04922	05D	W70-04966	02J	W70-05010
06E	W70-04879	02D	W70-04923	05D	W70-04967	02L	W70-05011
06E	W70-04880	02D	W70-04924	05D	W70-04968	02L	W70-05012
05G	W70-04881	03A	W70-04925	05A	W70-04969	02L	W70-05013
05G	W70-04882	03A	W70-04926	05D	W70-04970	02L	W70-05014
05G	W70-04883	03A	W70-04927	05D	W70-04971	02L	W70-05015
05G	W70-04884	03A	W70-04928	05D	W70-04972	02L	W70-05016
05G	W70-04885	08G	W70-04929	05D	W70-04973	02L	W70-05017
05G	W70-04886	03A	W70-04930	05D	W70-04974	02L	W70-05018
05G	W70-04887	08G	W70-04931	05D	W70-04975	04A	W70-05019
05G	W70-04888	03A	W70-04932	05D	W70-04976	04A	W70-05020
03A	W70-04889	03A	W70-04933	05D	W70-04977	02H	W70-05021
03A	W70-04890	03A	W70-04934	06B	W70-04978	04A	W70-05022
05E	W70-04891	03A	W70-04935	05B	W70-04979	02E	W70-05023
05E	W70-04892	03A	W70-04936	08A	W70-04980	02J	W70-05024
08A	W70-04893	03A	W70-04937	02B	W70-04981	02J	W70-05025
08C	W70-04894	03A	W70-04938	05D	W70-04982	07A	W70-05026
05D	W70-04895	03A	W70-04939	06B	W70-04983	08A	W70-05027
05D	W70-04896	03A	W70-04940	04A	W70-04984	04A	W70-05028
05D	W70-04897	03A	W70-04941	03C	W70-04985	04A	W70-05029
05C	W70-04898	03A	W70-04942	06A	W70-04986	04A	W70-05030
06B	W70-04899	03A	W70-04943	06A	W70-04987	04A	W70-05031
06A	W70-04900	03A	W70-04944	06A	W70-04988	04A	W70-05032
06A	W70-04901	05D	W70-04945	06A	W70-04989	04A	W70-05033
05C	W70-04902	05D	W70-04946	06B	W70-04990	02E	W70-05034
06C	W70-04903	03A	W70-04947	06A	W70-04991	08B	W70-05035
06C	W70-04904	03A	W70-04948	04A	W70-04992	08B	W70-05036
03A	W70-04905	08G	W70-04949	02L	W70-04993	08B	W70-05037
03C	W70-04906	03A	W70-04950	02J	W70-04994	08B	W70-05038
03B	W70-04907	03A	W70-04951	02L	W70-04995	08B	W70-05039
02F	W70-04908	03A	W70-04952	02L	W70-04996	08B	W70-05040
02I	W70-04909	03A	W70-04953	02L	W70-04997	08B	W70-05041
02A	W70-04910	03A	W70-04954	02L	W70-04998	08B	W70-05042
03F	W70-04911	03A	W70-04955	02L	W70-04999	08B	W70-05043

ABSTRACT SOURCES

Source	Accession Number	Total
A. Center of Competence		
U.S. Geological Survey - Hydrology	W70-04545 -- 04585 04589 -- 04616 04694 -- 04742 04744 -- 04760 04993 -- 05034 04689	178
University of Texas - Wastewater Treatment	W70-04761 -- 04794 04796, 04798 04800 -- 04802 04804 -- 04806 04896	43
University of Arizona - Arid Lands Water Resources	W70-04906 -- 04924 04903 -- 04904	21
Bureau of Reclamation - Engineering Works	W70-04617 -- 04624 04627 -- 04636 04638 -- 04647 04893 -- 04894	30
University of Wisconsin - Eutrophication	W70-04808 -- 04823 04979	17
Rutgers - The State University - Water Resources Economics	W70-04824 -- 04830	7
University of Chicago - Metropolitan Water Resources Management	W70-04832 -- 04848 04898 -- 04901	21
University of Florida - Eastern U.S. Water Law	W70-04857 -- 04886	30
Cornell University - Policy Models for Water Resources Systems	W70-04986 -- 04992 04905	8
Vanderbilt University - Thermal Pollution	W70-05035 -- 05043	9
North Carolina State University - Textile Wastes	W70-04849 -- 04853 04960 -- 04976 04586 -- 04588 04626, 04637, 04625, 04795, 04797, 04799, 04803, 04807, 04831, 04743, 04895, 04897, 04945, 04946, 04977	40
B. Others		
Oak Ridge National Laboratory	W70-04656 -- 04683 04925 -- 04944 04947 -- 04959	61
Office of Water Resources Research	W70-04544, 04648, 04690 -- 04693 04980	7
Office of Saline Water	W70-04649, 04889 -- 04892	5

ABSTRACT SOURCES

Source	Accession Number	Total
Louisiana Water Resources Research Institute	W70-04650, 04856	2
Massachusetts Water Resources Research Center	W70-04651	1
Federal Water Pollution Control Administration	W70-04652 -- 04655	4
New Jersey Water Resources Research Institute	W70-04684, 04686	2
Texas Water Resources Institute	W70-04685, 04687, 04983	3
Hawaii Water Resources Research Center	W70-04688	1
State of Washington Water Research Center	W70-04854	1
North Dakota Water Resources Research Institute	W70-04855, 04985	2
U.S. Coast Guard	W70-04887	1
Bureau of Mines	W70-04888	1
University of Michigan	W70-04902	1
American Society of Civil Engineers	W70-04978	1
Environmental Technical Applications Center	W70-04981	1
Iowa Water Resources Research Institute	W70-04984	1

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Subject Fields

- NATURE OF WATER
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- WATER QUALITY MANAGEMENT AND PROTECTION
- WATER RESOURCES PLANNING
- RESOURCES DATA
- ENGINEERING WORKS
- MANPOWER, GRANTS, AND FACILITIES
- SCIENTIFIC AND TECHNICAL INFORMATION

INDEXES

- SUBJECT INDEX
- AUTHOR INDEX
- ORGANIZATIONAL INDEX
- ACCESSION NUMBER INDEX
- ABSTRACT SOURCES

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